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An Extinct Giant-Shark

The Race Probably Died Out Through Its Own Rapacity

By Louis Hussakof

It is perhaps not generally realized that some species of sharks are among the hugest of marine animals, yet it is a fact that certain of them among them can be compared only with the whale. These giant sharks, however, are not well known, they are very rare, turn up in most out of the way places, and usually disintegrate before they can be carefully measured or studied. The largest species living at the present day are the great Whale Shark and the Basking Shark. The former is known from specimens stranded at various times at the Cape of Good Hope, on the coasts of India, Peru, Lower California, the Pacific archipelagoes, and, most recently, Florida. It is thus very widely distributed. It attains a length of over fifty feet; a specimen taken in the Seychelles in 1863 was measured and found to be over forty-five feet, and others recorded from the same locality by a reliable observer were over fifty. Fortunately, this monster is quite harmless. It has very small teeth and feeds upon the minute organisms abounding at the surface of the sea, which it strains through its gill rakers. The same is true of the great Basking Shark, which is found especially in the Arctic Ocean. This species approaches the Whale Shark in size and like it is an entirely harmless creature, feeding upon the micro-organisms of the sea.

But if the largest sharks of to-day are harmless, the same is not true of their congeners in the past. In Eocene times, the geologic age, during which mammals rose to their place of supremacy in the animal world, there lived in the sea a giant shark larger than any of the present day, and withal a most terrific monster. This shark has received considerable attention during the past year at the American Museum of Natural History, through the fact that the Museum procured several hundred teeth of this species which were set up in a restoration of its jaws. The teeth were collected many years ago from the phosphate beds of South Carolina, by the late Mr. Joseph Cohn.

A word about these jaws; as seen from the picture they are sufficient size, opened up, to allow five or six men to walk abreast right into the mouth. The teeth are arranged in rows above and below, those in the middle of each row being the largest. One of them which was especially measured is four and one-quarter inches wide at the base of the crown and six inches high. There are twenty-four teeth in the upper front row and twenty-four in the lower, and back of each of these rows there are three more, not seen in a front view, which are intended to take the place of any teeth in the front row which may be lost. The edges of each tooth are like sharp knife blades, or to be more accurate, sharp saw edges, since they are serrated. What a tremendous engine of destruction this jaw must have been in life. Fancy the millions upon millions of fishes that must have been guillotined by the snapping together of this gigantic mouth. Perhaps never was there evolved an engine of destruction more terrible than this. Not even the dental battery of the gigantic Dinosaur, *Tyrannosaurus rex*, surpassed it in power. And what manner of shark was this to whom belonged these jaws? Have we any data by which to picture its size and appearance? Fortunately, we have. There survives at the present day a closely related shark which gives us an idea of the appearance of its gigantic extinct relative. This surviving species is the Great White "Man-eater," known to scientists as *Carcharodon rondeleti*, which is washed up on the Atlantic coast once in a long while. One of these sharks, a rather small specimen, ten feet long, was cast up on the Massachusetts coast in 1883, and received careful attention at the hands of Dr. W. G. Stevenson, who published a description and accurate measurements of it. Its teeth were one and one-fourth inches high, and if we compare the size of its jaws with those of the extinct shark (*Carcharodon megalodon*) we may safely conclude that the latter must have been in the neighborhood of seventy or eighty feet in length. It was thus as large as a Sulphur-bottom Whale, the hugest of all whales. *Carcharodon megalodon* is not the only extinct species of this kind of shark. To judge from the fossil teeth which occur in different parts of the world, there lived at least a dozen other species in the sea contemporaneously with it, which have also become extinct. The surviving species, the Great White "Man-eater," is exceedingly rare and may be regarded as on the verge of extinction. What was the cause of such a gigantic and terrible monster becoming extinct?

Not knowing all the conditions of life of such a creature, it is not possible to give an accurate answer to this question, but we may venture an explanation. We know that a shark of such gigantic proportions must have consumed enormous quantities of fish. Owing to its rapacious habits these fish must have decreased in number sufficiently in course of time to have deprived it of its staple article of food and thus must have led to its extinction. This view is made more probable when we remember that the giant shark lived in the sea with a dozen or more other species which were constantly competing with it for food.

Death-trap of an Eighty-foot Shark

The fierce dental battery of the monster

A Recently Installed System of Electric Train Lighting

Dynamo Driven from the Coach Axle

The accompanying illustration Fig. 1 and drawing Fig. 2, show the automatic dynamos, governors and switching apparatus of an electric train lighting equipment recently developed at Silvertown, England. This consists of a dynamo driven from the coach axle, and carrying on its shaft a governor which is used to operate the controlling apparatus. There is a double battery of accumulators provided, one of which is normally connected to the terminals of the lamp circuit, while the other is connected to the armature terminals so that it may receive a charge.

The electric generator is of usual construction except that the field magnets are differentially wound, one winding being a shunt winding connected by the switch gear to the terminals of the battery, which at any given time is connected to the lamps (hereafter called the discharge battery), while the other is a series winding through which is passed the whole or a part of the current supplied by the dynamo to the second battery, called the charge battery. This winding is connected up by the switchgear so that it opposes the shunt winding, and tends to demagnetize the magnets and weaken the field in which the armature is rotating. Connected as a shunt to the series winding there is a resistance or diverter, which can be adjusted by hand to regulate the proportion of the charging current passing through the series winding; so that if the conditions of working are such that there is an increase in the ampere hours or discharge from the batteries, the rate of charge of the charge battery also can be increased, or if there is a decrease, the rate can be diminished.

By so adjusting the diverter resistance that, with any pre-determined value of the charging current, the proportion of this current passing through the series coils gives a demagnetizing effect equal to the magnetizing effect of the shunt coils, it is possible to limit the charging current to something less than this predetermined value, as there would be no magnetizing force and the dynamo could not generate an electromotive force and consequently could not supply any current to the battery. At the same time, as none of the current passing to the lamp circuit passes through the series coils, their demagnetizing effect is not dependent on the number of lamps in circuit, and whether full, half or no lights are on, it is still impossible for the charging current to reach the predetermined value.

The armature shaft of the dynamo carries a centrifugal governor, so arranged that it operates a cut-in switch when the speed of the armature is such that the dynamo, if excited by the shunt coils only, would give a voltage equal to the normal lamp voltage. This cut-in switch first connects the shunt circuit to the discharge battery so as to excite the magnets of the dynamo, and then connects the armature of the dynamo to the charge battery through the demagnetizing series coils and its diverter, and to the discharge battery and lamp circuit through the lamp resistances.

The governor also carries on its collar a projection which, as soon as the armature begins to rotate, engages with a rocking lever. This latter operates a reversing switch, provided there has been a change in the direction of rotation of the armature. This collar works against a light spring for the first half inch of its movement, so that it is quickly drawn away by the governor when making only a few revolutions per minute, sufficient for the projection to be clear of the rocking lever and thus prevent the repeated striking of the former against the latter.

The reversing switch not only changes the connections between the armature and the batteries so that the dynamo gives current in the proper direction, but also changes the batteries over so that the one that was the discharge battery becomes the charge battery and *vice versa*. In addition to the above apparatus, a lamp switch is provided, so that all the lights, or half lights can be switched on. This switch also couples the two batteries in parallel for charging when all lights are switched off.

The accompanying drawing Fig. 2 shows the general arrangement of the dynamo and the construction of the governor and switchgear. The numbers on the switchboard where a circle is shown denote the points at which the connections pass through the switchboard; the other numbers (at the squares) refer to the reversing and cutting in and out switches. Thus 9, 10 and 11 are the cutting in and out switches and 1, 3, 7, 5 and 2, 4, 8, 6 upper contacts and 1, 7, 3, 5 and 2, 8, 4, 6 lower contacts on the reversing switch.

If it is assumed that the train is just starting and all the lamps are switched on, the direction being such that the reversing switch is in position shown by the full lines (upper contacts), the current will flow through the various circuits in the following manner—from No. 1 battery to upper contacts 6 and 8, to lamp switch and back to No. 1 battery. A part of the current will be supplied by No. 2 battery through contacts 2 and 4, through the series winding and its diverter, then through the lamp resistance to the lamps and back to No. 2 battery.

As soon as the speed has been increased sufficiently the shunt winding will be connected to No. 1 battery to excite the shunt through contacts 6 and 8, to shunt coils and contacts 9 and 11 and back to No. 1 battery, thus insuring the voltage being built up before the armature is connected with the batteries and lamps.

It is clear that an increased speed will now connect 9 and 11 to 10, and the armature will supply current to the load in the following manner: The current passes from the armature to contacts 1 and 3, after which it divides, part going through the lamp resistances to the lamps and part through the series winding and its diverter and contacts 4 and 2 to No. 2 battery (which is the charge battery when running in this direction). The current from No. 2 battery will now join that from the lamps and pass through contacts 11, 10, 7 and 5 back to the armature.

In case only half lamps are required, the current will flow as before except that there will be no circuit through one group of lamps, nor through one of the lamp resistances, which were in parallel for full lights. In the event of no lights being used, the two batteries are placed in parallel by the act of switching the lights off. In this case, the current will flow in the following manner: from the armature to contacts 1 and 3, after which it divides, part going to the series winding and its diverter and part to the "half light" lamp resistance.

After passing through the series winding diverter and lamp resistance in parallel the current again divides, passing through both batteries and the shunt winding in parallel and through contacts 11, 9 and 10 to 7 and 5 to the armature.

It is claimed that the advantage gained by this system of regulation is that it is practically impossible to charge the battery at an excessive rate, and that it provides an easy means of adjusting the amount of charge to the requirements of the battery. This should appreciably reduce the cost of maintenance of the battery, as it will not be necessary to wash it out or replace plates as frequently as heretofore.

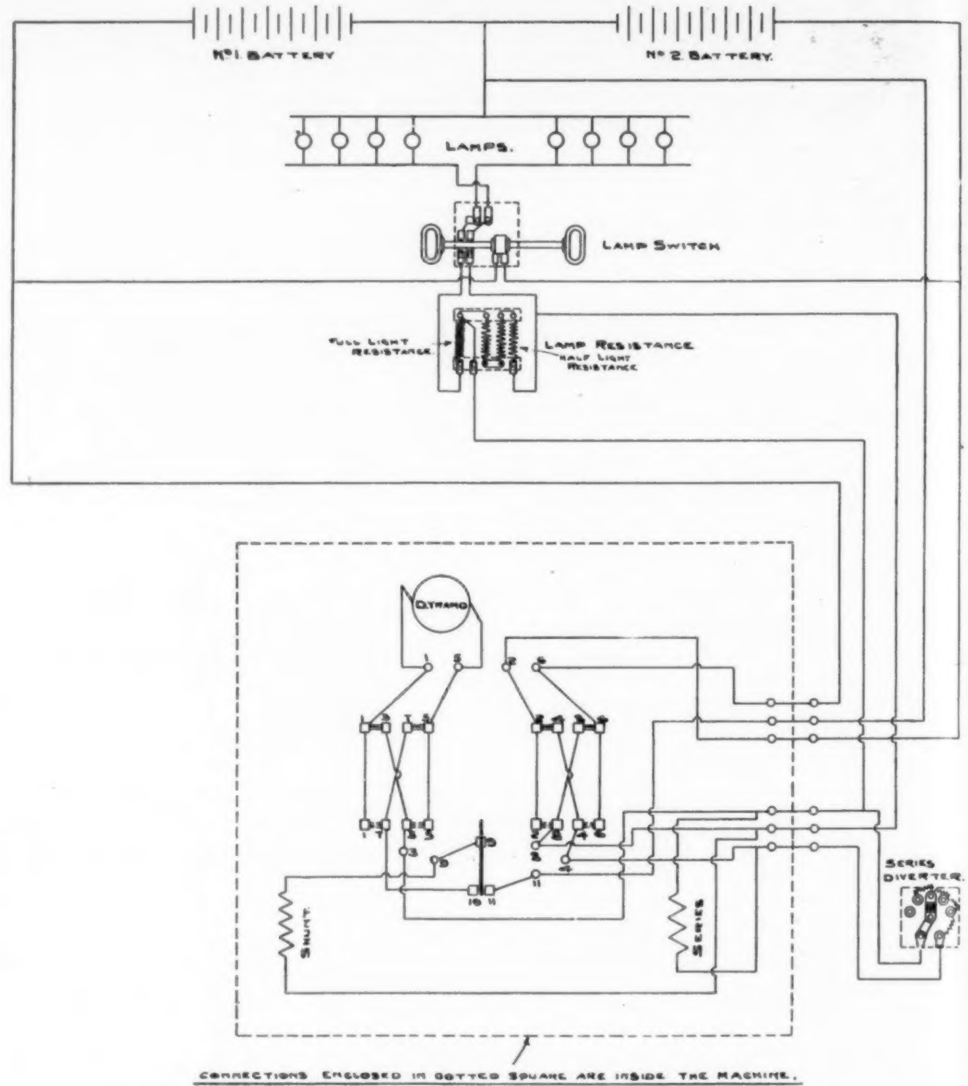

Fig. 2.—Silvertown Train Lighting System. General Diagram of Connections.

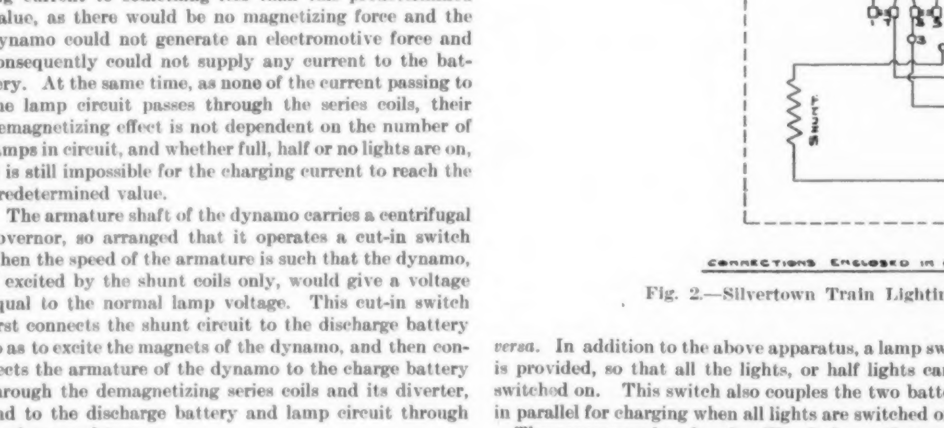

Fig. 1.—The Dynamo With Its Governor.

Internal Combustion Motors for Life Boats*

Gasoline Engines Designed to Meet the Severest Conditions of Service

The advantages of having some form of motive power beyond sails and oars fitted on a lifeboat have been long recognized by those responsible for such boats, and will be obvious to anyone who gives the matter a thought. The Ramsgate lifeboat, for instance, has had for many years to be towed to windward of a wreck by the famous old Board of Trade tug "Aid," and many exciting incidents have fallen to her lot. There is now a new "Aid," which is doing equally good service. The draught of a tug, however, prevents her from approaching close to a wreck on the Sands, so that the lifeboat has to be cast off and left to fend for herself just at the critical time, when, if she misses the wreck, she may be blown right away to leeward and the tug will have to go back and search for her and again tow her to windward with a loss of much valuable time. Steam in the form of a water-tube boiler and an engine with a propeller or a pump for jet propulsion has been tried as a means of getting over the difficulties of towing, and good service it has rendered in the four or five boats of this type which have been built since the first one in 1899. Such boats are, however, so large and heavy that they have to be kept always afloat, so that they cannot be used on all stations, and it is only the advent of the internal combustion engine that has made it possible to fit motor power on boats which are hauled up and launched off a slipway.

Particulars of Motor-driven Lifeboats now in Service.

Station.	Boat. Date.	Type.	Size.	Maker.	B.H.P.	Propeller. Diameter.	Pitch.	Reverse gear.	Speed, knots developed.	Pints consumed per hour.	Remarks.
			ft. ft. in.			in.	in.				
Sunderland	1904	S.R.	38 × 8 0	Fay & Bowen	11	—	—	Durham Churchill	5·9	12	Experimental boats
Teesmouth (Reserve No. 2)	1906	S.R.	42 × 11 0	Tylor	30	21	15	Buffalo	7·2	18·5	
Newhaven (old)	1907	S.R.	37 × 9 3	Thornycroft	24	19	14	Thornycroft clutch	7·27	15·6	
Walton-on-Naze	1906	N. & S.	43 × 12 6	Blake	32	22	21	Blake clutch	6·8 6·98	20·4	
Stronsay	1908	W.	43 × 12 6	,,	40	22	24	G.R.P.	7·2 6·4	25 20	
Stromness	1908	S.R.	42 × 11 6	Tylor	30	18	21	V.R.P.	6·65 5·86	21 16	
Fishguard	1908	S.R.	40 × 10 6	,,	24	19½	23	M.R.P.	6·70 5·87	22 14	
Broughty Ferry	1909	W.	40 × 11 0	,,	40	21	22	V.R.P.	7·2 6·7	34·5 28·5	
Donaghadee	1909	W.	43 × 12 6	Blake	40	24	24	H. and S.	6·9 6·38	29·25 18·75	
Wicklow	1910	S.R.	40 × 10 6	Tylor	40	22	22	,,	7·12 6·96	36 31·5	
Seaham	1910	W.	38 × 10 0	Wolseley	34	21	21	V.R.P.	6·97 6·78	33 23	
St. Abbs	1910	W.	38 × 10 0	,,	34	21	21	,,	7·15 6·48	33·75 24	
St. Davids	1911	S.R.	40 × 10 6	Tylor	40	22	22	H. and S.	7·29 6·73	34·5 26·25	
Tynemouth (new)	1911	S.R.	40 × 10 6	,,	40	22	22	Gardner No. 4	—	—	
Campbeltown	1911	W.	43 × 12 6	,,	55	24	24	,, ,,	—	—	
Beaumaris	1911	W.	43 × 12 6	,,	55	24	23	,, ,,	—	—	
Peterhead	1911	W.	43 × 12 6	,,	55	24	23½	,, ,,	—	—	
Clacton-on-Sea	1911	W.	45 × 12 6	,,	40	—	—	,, ,,	—	—	
Newhaven (new)	1911	S.R.	38 × 9 9	,,	35	—	—	,, No. 3	—	—	

Note.—Reverse gear: G.R.P. = Gaine's reversible propeller. V.R.P. = Villinger's reversible propeller. M.R.P. = Meissner's reversible propeller. H. and S. = Hesse and Savory reverse gear.

Motor-driven Life Boats in British Service.

At the present time there are nineteen boats fitted with this form of power in actual service round the British coast, of which the table above gives the leading particulars.

Hitherto motors by five different makers have been tried: Fay and Bowen, Thornycroft, Blake, Tylor, and Wolseley, the majority being by Messrs. Tylor & Co., of King's Cross. The first four boats, each with a different motor, by the first four firms mentioned, were existing boats converted to motor power for experimental purposes, the powers varying from 11 horse-power to 32 horse-power, but this power has now been standardized and three sizes are recognized by the National Lifeboat Institution—34 horse-power, 40 to 50 horse-power and 55 to 60 horse-power, according to the size of the boat—all the motors being required to run at a speed not exceeding 700. As the conditions required of a motor for use on a lifeboat are so entirely different from those which obtain in ordinary marine work, it is necessary to be fully acquainted with these special requirements before venturing to describe or criticize any engine designed for this special purpose, or injustice will be done. In order to get the latest views on these conditions we obtained from Capt. Holmes, the Chief Inspector of Lifeboats of the Institution, and Mr. Small, his technical assistant, their opinions as to the points which should be embodied in a motor suitable for lifeboat service; though when we first heard these conditions stated we were inclined to consider some of them altogether unnecessary and purposeless, we must admit that further knowledge of the circumstances based upon our examination of the Campbelltown lifeboat at the Thames Ironworks, where all the hulls are made and the machinery fitted, has almost entirely removed our objections on the main points, though we still think that some of the minor details might well have been left to the discretion of the engine builders. That a motor for this or any other purpose shall possess Capt. Holmes' first desired attributes of reliability, simplicity and strength will be admitted by all, and the attainment of the element of fewness of parts for the sake of simplicity by limiting the number of cylinders in any engine to four is hardly open to criticism. Other very right and proper requirements are: that there shall be no aluminium; that the motor shall prove its ability to run for twelve hours continuously and without being touched; that a half-compression arrangement shall be fitted to facilitate starting up; that extra large water jackets shall be fitted as the engine is completely closed in; that the carbureter and magneto shall be placed high up on the motor; that the cooling water shall not be led into the exhaust, where it might find its way back into the valves in case of a capsize; and that a water-jacketed silencer shall be fitted. Special conditions due to the peculiar nature of the service call for the ability of the engine to run while the boat is hauled up on a slip at a longitudinal angle of 1 in 4—as the engines are run for a few minutes two or three times a week while the boat is lying at this angle, just to see that everything is in order—and the ability to run while the boat has a list of 25 degrees either way, or a momentary list of 45 degrees, to ensure that the motor shall be able to keep running when the boat is under sail as well or when it is struck on the beam by a heavy sea. The conditions also require that an arrangement shall be fitted to switch off the ignition if the boat is heeled to an angle of 60 degrees to 70 degrees, so that if the boat is upset the motor shall not continue running when righted and leave the crew in the water. This is obtained by means of a roller resting in a fork through which the current for the ignition has to pass, so adjusted that when the predetermined angle is reached the roller will leave one side of the fork and break the circuit. It is further very necessary that a governor shall be fitted to prevent racing, which even with the propeller housed in a tunnel and fitted some distance from the stern post, is otherwise difficult to prevent in service condition.

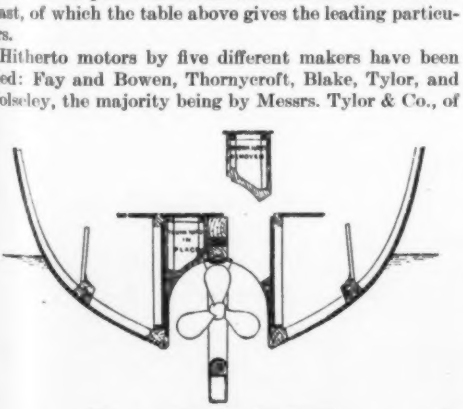

Fig. 2.—Propeller in Tunnel.

Mechanical forced lubrication to the bearings and crank pins is, of course, a necessity in order to meet the severe conditions of running when inclined at a fore-and-aft angle of 1 in 4 or a list of 25 degrees, though splash lubrication is fitted as a standby in case of breakdown of the pump system at sea. Pressure feed to the carbureter, with the necessary pressure obtained from a small air pump would also seem to be a necessity in order to keep the weights low, which is a *sine qua non* in the self-righting boats particularly. The feed does not, however, lead direct to the carbureter, but to a small gravity receiving tank inside the motor casing, so that a temporary failure of pressure would not lead to a stop.

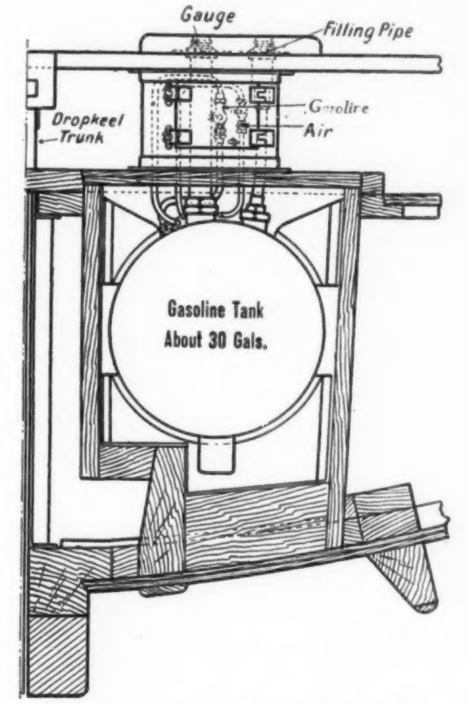

Fig. 1.—Arrangement of Gasoline Tank.

We are almost inclined, however, to question the wisdom of entirely ruling out dual ignition—as is done on the self-righting boats—for the sake of simplicity; though there would certainly be more wires, it would tend to increased reliability, and if a man of the type which is obtainable to look after these motors can be got to understand one ignition he should equally well be able to understand two, while the unsightliness of the double lot of wires is entirely hidden away in the casing. Of course, an accumulator would be out of the question as one of the alternatives, as in the case of a capsize the acid would be spilt and the accumulator rendered useless, but dry batteries might very well be substituted for use with a coil. We are not surprised to learn that the officials of the Institution have a preference for the low tension magneto, as it is more easily understood and less affected by damp, but the inclusion of this in the specification necessitates a departure from standard for very many makers, so that the price probably goes up.

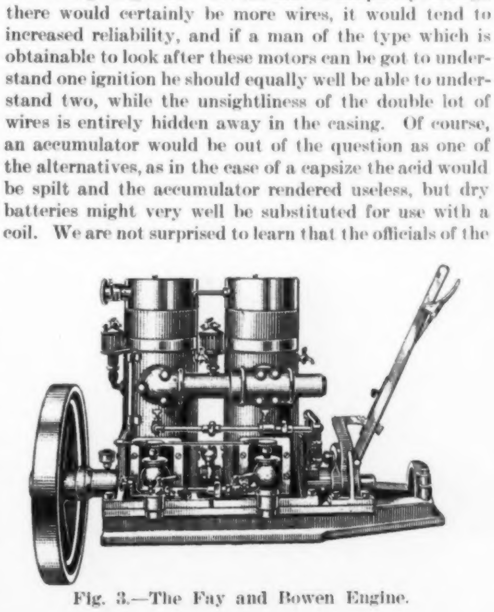

Fig. 3.—The Fay and Bowen Engine.

The condition laid down in the specification with which at first we chiefly felt inclined to disagree is that the valves shall be on opposite sides with a separate cam shaft for each set, our objection being that this would call for a considerable alteration from standard patterns

* Reproduced from *The Engineer*.

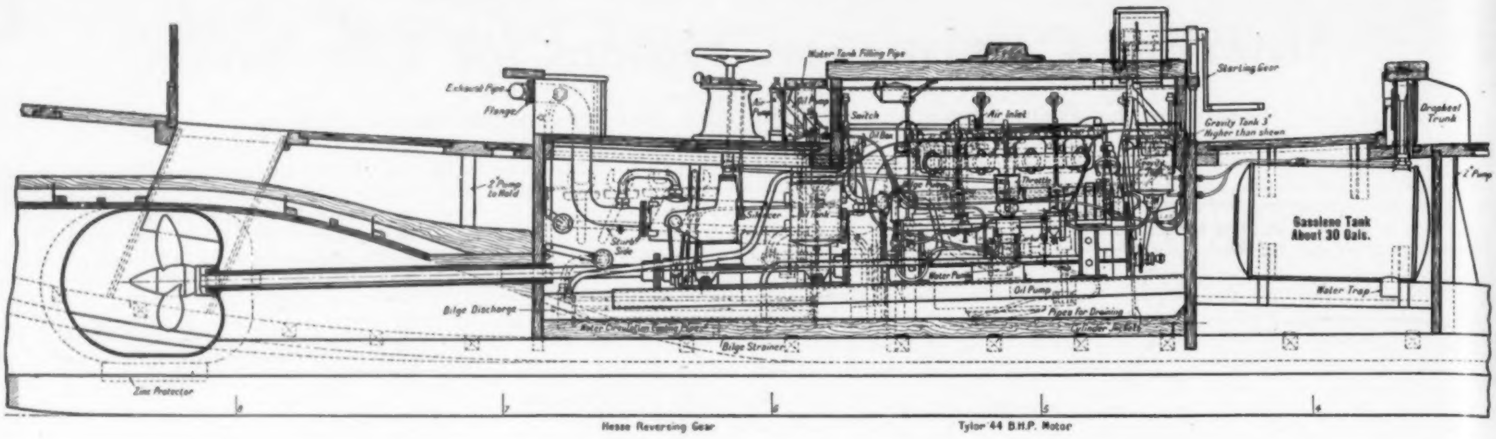

Fig. 4.—Longitudinal Vertical Section Through the Latest Type of Motor Equipped Life Boat.

in the case of many makers, so that competition would be limited or the price would be increased, for which we could see no corresponding advantage. When the motor is seen in place, however, the reason for the demand becomes obvious. The engine is installed in a pit below the level of the deck, so that the mechanic has to get at things from above instead of, as usual, from below, and the valve springs, etc., are not very accessible as it is. If the valves were all on the same side the inlet piping and the water jacketed exhaust piping would together render them entirely inaccessible without largely increasing the width of the motor casing, which is impracticable, while on the opposite side much space would be wasted. Hence we cannot see what other decision could be arrived at. In addition to this there is somewhat minor advantage to be gained, in that the weights are better distrib-

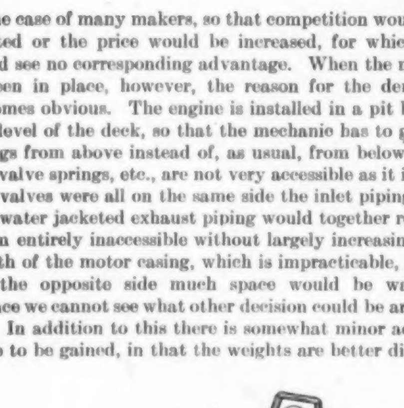

Fig. 5.—Section at Forward Bulkhead of Motor Compartment. Looking Aft.

uted on each side if the center line. This is of some importance, for it is not only the weights of the valves and pockets which have to be considered, but that of the big water jacketed exhaust box, which alone weighs some 60 pounds. This is not a question of trim, for that could of course hardly be affected, but the addition of a motor has greatly complicated the question of self-righting in these boats, and great care has to be exercised in the distribution of the weights.

A constantly running gear type of pump is required by specification to keep the engine bilges drained, as the base of the motor chamber is below the level of the water and the self-draining deck. Designed originally to allow the engine to run when the boat is hauled up on a slip, fresh water cooled by pipes round which sea water circulates, as shown in the accompanying line-drawings, Figs. 4, 5, 6 and 7, has now been adopted as standard practice for cooling the jackets, so that there is no fear of incrustation in the jackets nor of the water inlet being choked by weeds or wreckage. Only about 21 gallons are required in the supply tanks and coolers for a long run, and arrangements are made for the admission of sea water in case of the exhaustion of this supply. The whole system is, of course, drained off in frosty weather.

Having now sketched the general conditions required by the Institution in the construction of the motor and its accessories, we will deal briefly with the installation and the conditions under which it has to work, bearing in mind that at present the motor is only looked upon as an auxiliary to the sails and oars. In the first place, it will be noted by the drawings of the latest type shown herewith that the motor has to be installed in an entirely air-tight and water-tight box or pit below the level of the deck, which covers a space filled with air tanks; thus it is only possible to obtain access to the lower part of the motor while in the boat with some difficulty. This pit is entirely covered by a pair of strong hinged flaps which are screwed down on a rubber joint by a row of thumb screws. The coaming on which these flaps rest, which rises some 8 inches above the deck, can be removed when getting at the crank case. It has to be—and, in fact, cheerfully is—admitted then that if anything happens to the motor when on active service, very little more than adjusting a plug can be done by lifting a flap and protecting the opening with a dodger. If the trouble is more than this it is simply let alone, masts and sails are raised or oars put out, and the best progress possible made under the old conditions. We were interested to learn, however, that owing to the fact that no less than four filters are fitted in the fuel system, no stop has ever been experienced due to a chokage of the carbureter. Accessibility in the motor itself is then a matter of quite minor importance, as it has anyhow to be lifted out of the boat before anything in the nature of a serious examination or overhaul can be attempted, though we were informed that the cylinders could be lifted off, but we imagine this would be a troublesome job. The protection of the magneto from damp is very thoroughly carried out, and the engines are only accepted on the conditions that they shall start up at once after the boat has been capsized and righted, when in the ordinary way the whole of the motor would have been swamped. When this capsize takes place a certain amount of gasolene naturally flows out into the bilges till the boat is righted again, but as this is all in an inclosed space, unless there is a short circuit somewhere in the ignition system to cause a spark, there is no danger, and it will soon be pumped out by the bilge pump when the engine has been got running again. The tanks for the main supply of gasolene are fitted in separate copper-lined chambers, the filler and gage projecting through a thwart, where they are protected by a wooden chock, as shown in Fig. 1. In the event of any leakage from the tanks it would only escape into this chamber, whence it is drained out through a hole in the bottom when the boat is hauled up. Normally both tanks are used together, but either can be shut off in the event of any loss of pressure in one.

The carbureter is protected from wet in a similar way to the ignition; the air is drawn into the motor casing

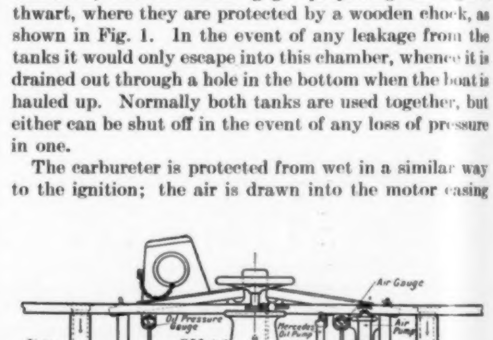

Fig. 6.—Section at Eight Inches Aft of No. 6 Station. Looking Forward.

when in a heavy sea from the big air casing at the end of the boat through a special form of valve, which closes against the admission of water in case of a capsize. This arrangement has the additional advantage of keeping the casing well aired and preventing dry rot. There is, however, a vent to the motor casing which can be closed by a water-tight cover or left open if desired in smooth water. The throttle control is led from the engine through a gland in the casing to the reversing wheel, the starting handle also passing through a water-tight gland. Thus the

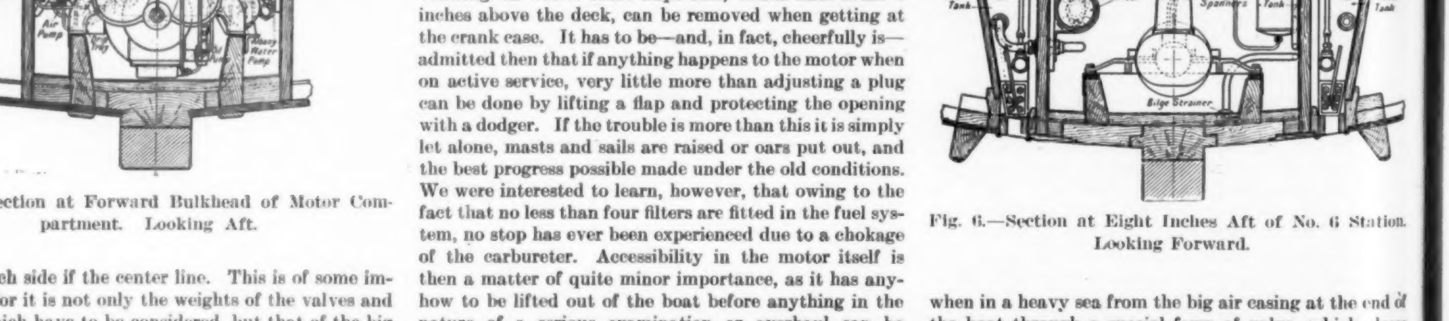

Fig. 7.—Plan View of the Motor Equipped Life Boat.

engine when once started has to take care of itself entirely without the least attention.

Though not directly a motor question, it may here be said that the greatest difficulties encountered in the use of a power propelled lifeboat are the prevention of racing

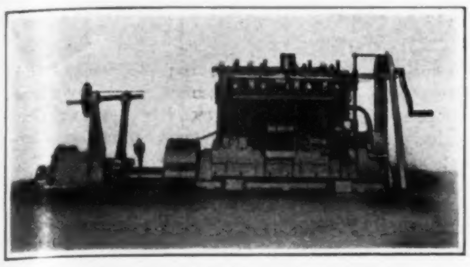

Fig. 8.—Thornycroft Engine for Newhaven Boat.

in the awful seas these boats have to face, and the fouling of the propeller by ropes at the wreck or when launching from the carriage. Both these difficulties have been overcome by fitting the propeller a considerable distance forward of the stern post and in a tunnel formed round the deadwood—see Fig. 2 and Figs. 4, 5, 6 and 7—which has to be retained in order to help to keep the boat on her course in a sea way. The formation of this tunnel is a pretty piece of shipwright's work, and it probably has some effect in decreasing the efficiency of the propeller, but any loss in this direction is amply compensated for by the protection it affords. Both reversing blade propellers and reversing gears of various types have been tried on these boats, but we rather gather that the feeling of the officials of the Institution is in favor of the reversing gear.

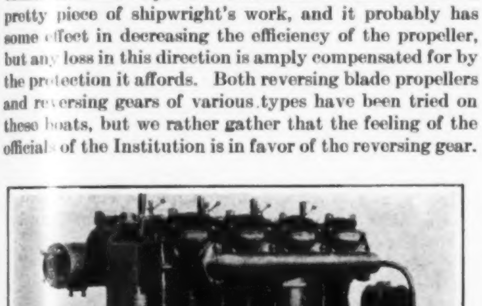

Fig. 10.—Fifty-five Horse-power Tylor Engine.

Access to the propeller, to clear it from weeds, etc., is obtained through a water-tight removable hatch, shown raised in Fig. 2.

Having now made clear the conditions which are required in a motor for lifeboat work, by those responsible and by the nature of the services, we are free to describe and criticize the motors which have already been fitted, from a fresh standpoint, unfettered by the usual conditions which apply to marine work, though we can hardly criticize the earlier makes at all.

The Fay and Bowen, or, as it is now called, the Mitcham motor, is the only two-cycle engine that has been tried by the Institution, and this was fitted as long ago as 1904 in one of the experimental boats which is still doing good work at Tynemouth. With two cylinders, 5½ inches by 5½ inches, the power then developed was 11 at 460 revolutions per minute, but we are informed that an engine with the same size of cylinder is now capable of giving 16 horse-power at the same speed. The engine is of the well-known type with crank case compression, mixture valve carburation, and low-tension magneto (see Fig. 3). The driving gear for the low-tension ignition plug is entirely covered in, and we have no doubt that it was this feature which first principally attracted the attention of the Institution to this motor. At the time these earlier engines were fitted it was, of course, impossible for the Institution to lay down any special conditions, so that the ordinary standard engine was accepted, and it is from the experience gained with this and the other earlier engines that the present-day specification has been drawn up.

The Thornycroft engine fitted to the Newhaven self-righting boat in 1907 was also made before the days of the present strict specification, and was largely of standard design, except for the low-tension magneto. The required 24 horse-power was given at 1,000 revolutions per minute with cylinders 4¼ inches diameter by 5 inches stroke; no arrangement for access to the crank case was provided, though with the magneto and water pump driven by gears along the front of the engine the valve springs are still left accessible. As the engine shown in Fig. 8 is of a somewhat old pattern and well known, nothing further need be said.

The Blake motor was fitted again to one of the four experimental boats in 1906, and had high-tension magneto ignition, with a large diameter clutch with a motor car type of reversing gear, as shown in the illustration, Fig. 9. The engine has all along been designed for purely marine purposes, and has quite good doors in the crank case, in spite of the two cam shafts which are carried in special little cases cast on the crank chamber, which is all in one piece with end disks bolted on to allow the crank shaft to be put in from the ends. The 32 horse-power is obtained at the reasonable speed of only 550 revolutions per minute. There are points, such as the exposed gear wheels for the pump, which are not present-day practice, but this particular engine is now, of course, largely of historical interest.

The Tylor engine, of which twelve have now been fitted in the various boats, is shown in Figs. 10 and 11. Fig. 10 shows the inlet side of the 55 horse-power engine; Fig. 11 shows the 40 horse-power. As the larger engine embodies the latest views of the builders, we will confine our remarks to that alone, and in so doing we will not dwell upon the general features which have been commented upon above, but will merely draw attention to special details which would appear to be of interest. It will be noticed that the big doors, which extend the whole length of the crank case on each side, are very accessible, one being quite clear of obstructions, a point which is lacking in the smaller engine, while the other door only requires the removal of the lubricating oil pump driving gear, which is easily effected by the sliding engagement on the shaft. When this door is taken off, the cam shaft can be removed through the opening, and the connecting-rod brasses then adjusted. The pistons are only accessible by taking down the cylinders, which means the removal of a good deal of gear; but, as we have pointed out, this is not very material. It should be noted that the setting of the valves on opposite sides allows the low-tension ignition plug to be placed in the side of the valve chamber, which leads to a simpler arrangement of the trip rods than when the plugs are on the top. The advance and retardation of the spark is obtained as usual, with low-tension ignition, by moving the trip gear rollers to and fro across the center of the cam, but this is not used in practice on the lifeboats. It will be noticed that the magneto is inclosed in a water-tight case—almost a redundancy we should have thought, in view of the water-tight casing which encloses the whole motor. No wires are, however, used, strips of brass being employed instead, which makes a much neater looking arrangement, while the current is of such low intensity that there is no fear of the spark jumping as long as there is some clearance. The arrangement of the drive for the magneto and water pump across the front end of the engine by spiral gearing on the end of the cam shaft is much better than in the 40 horse-power engine, and keeps these parts well clear of the doors, valve springs, etc.

The actual size of the cylinders is 6⅝-inch bore by 7¼-inch stroke, and 72 brake horse-power has been obtained at 700 revolutions per minute, a good margin over the specified 55. The crank case is made of a special "Rolyt" bronze, which has a tensile strength of 14 tons per square inch, but the crank shaft bearings are in the top half, a point on which we have commented in a previous article. The carbureter, in addition to the lubrication, is arranged to work at the unusual angles mentioned above; the air pump for the supply of pressure to the fuel is seen at the after end of the engine in Fig. 10.

It will be noted that the governor acts on a throttle of its own entirely independent of the ordinary hand throttle, so that it is the governor and not the man that gives the word when at sea. In this engine the bilge pump is driven by friction off the fly-wheel; the water-cooled exhaust box is of welded steel, and not cast iron. The lubricating pump supplies oil after passing through a water cooler in the base of the crank case to all the main bearings and the big ends, and also to the cam shaft bearings. The water connections are interesting, the water being admitted to one cylinder and reaching the next through the brass bridge piece on the top of the cylinders, which can be seen in the illustration of the 40 horse-power motor (Fig. 11) and so on to the others. As the incoming water is first warmed by being passed through the jacket of the

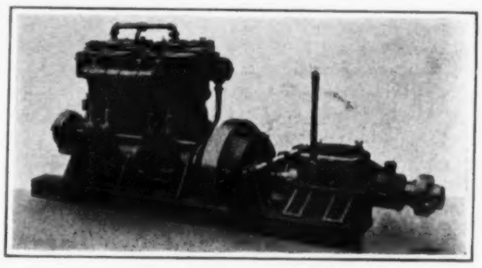

Fig. 9.—The Blake Motor.

exhaust piping, the temperature head between the first and last cylinders is reduced, and the actual difference in temperature between the two cylinders is not found to be sufficient to cause trouble or loss of efficiency. The motor has every appearance of being thoroughly well made and very strong, even perhaps rather on the heavy side, which should make it capable of standing any amount of rough usage.

The Wolseley engine, the fifth type of engine hitherto tried by the Institution, shown in Fig. 12, has cylinders 5 inches by 6½ inches, and was specified to give 34 brake horse-power at 700 revolutions per minute, though we understand that this was considerably exceeded on the bench tests. Owing to the fact that the engine was built to the same general specification

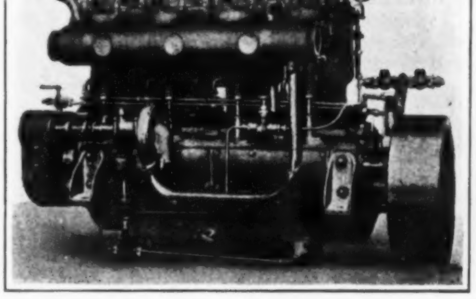

Fig. 11.—Forty Horse-power Tylor Engine.

as that of the Tylor, great differences are not to be noted, and many of the remarks made with regard to that engine will apply equally to the Wolseley. We note that the thicknesses of the cylinder walls and jackets are given in the specification, and these thicknesses appear to us to be greater than is the ordinary practice of the Wolseley Company, which has probably resulted in some increase in weight, which, we believe, is actually something over 1,700 pounds. The cylinders are fitted with drains at the bottom of the jacket leading to a pipe, which has a cock at each end, so that the jackets can be emptied whichever way the boat happens to be lying on the slip. In this case the crank case is of cast iron and the crank shaft of chrome steel, the area of any pair of crank shaft journals being specified as not less than 81 per cent of the area of the piston. We note that in this case—a Watson, that is, a non-self-righting type of boat—dual ignition is actually specified, a coil and accumulator for starting up and a Bosch high-tension magneto for running, a point on which we commented in dealing with the general conditions at the beginning of this article.

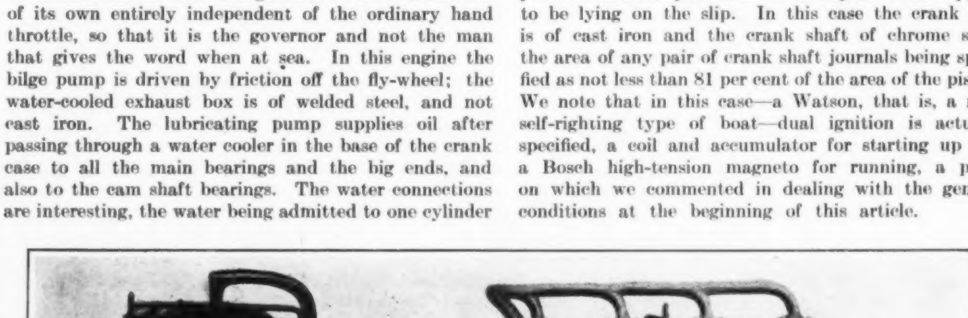

Fig. 12.—The Wolseley Thirty-four Horse-power Engine.

Acclimatization*

Can the White Races Become Permanent Populations in the Tropics?

By Raymond B. Bowen

The problem of human acclimatization comes up most frequently in connection with white races moving into the tropics, and the question which usually presents itself when acclimatization is mentioned is: Can white races become successfully acclimatized in the tropics? This question has more than mere physiological or medical importance, because it has to do so closely with the subject of colonization. In these days, when the older nations are looking for lands into which they can pour their surplus populations, it can easily be seen what a benefit it would be to all, if the above question could be answered in the affirmative.

It appears, however, that those very races which most need new colonies are the ones least fitted for life in the tropics. The Teutonic race and especially the Anglo-Saxon branch of it, is the one which most needs the new lands to expand into, and at the same time it is the one whose people are least immune to tropical diseases. Now, more than ever before, Europe is becoming crowded, and with America shutting her gates to foreigners, it is necessary for Europe to pick other places for her overflow. The tropics seem to present the only solution; but if it is found that white races cannot live there, the question still remains.

Let us now consider the facts in the case, as they are known to-day. First, what are the effects of a tropical climate upon the human body and its functions? William Z. Ripley[1] says that the respiration becomes more rapid, for a time, although it soon tends toward the normal; the pulse beats more quickly; the appetite is stimulated, but the action of the climate on the digestive organs is such that the individual, as a rule, becomes thinner The liver tends to increase in size, which is perhaps the cause of a certain sallowness of skin. A very important change, which has not perhaps been fully investigated as yet, is a temporary rise of temperature, which often lasts for some time after the individual leaves the tropics. He concludes that this rise varies from 0.3 degrees to 0.5 degrees. Ellen C. Semple, in her recent masterful work on geographic environment, states[2] that a tropical climate produces: "certain derangements in the physiological functions of the heart, liver, kidneys, and organs of reproduction. Bodily temperature rises, while susceptibility to disease and rate of mortality show an increase ominous for white colonization. The general effect is intense enervation; this starts a craving for stimulants and induces habits of alcoholism which are accountable for many bodily ills usually attributed to direct climatic influences. Transfer to the tropics tends to relax the mental and moral fiber, induces indolence, self-indulgences and various excesses which lower the physical tone. The social control of public opinion in the new environment is weak, while temptation, due to both climatic and social causes, is peculiarly strong. The presence of an inferior, more or less servile native population, relaxes both conscience and physical energy just when both need a tonic. The result is general enervation, deterioration both as economic and political agents."

The physical elements of climate, ranged in the order of their importance, are humidity, heat, and lack of variety.[3] When heat alone is considered, it does not seriously affect the human organism except when unduly extended. In this connection, Prof. Keller says:[4]

"The monotony of the unvaried heat works further upon the nervous system, tempting to excesses in general, and in particular to the use of stimulants. . . . It is not so much the degree of heat that debilitates; rather is it the endless persistence of a temperature often far exceeded by that of the temperate-zone summer."

Moreover, in the tropics, as in any other parts of the world, humidity adds to the discomfitures of heat. All authorities agree, therefore, that the regions where acclimatization is most difficult are to be found in the areas of excessive humidity, or roughly, where there is a maximum rainfall. In Cochin China the mortality of soldiers is almost double that in Tunis; and that is a good measure of the difference between a mere torrid climate and one which is very humid as well as hot, for humidity means that malaria is added to all the other difficulties inherent in climate alone. Humidity is more fatal in the tropics because there moisture and heat go together, while in the temperate zones the rainfall is heaviest in the cooler seasons.

Within the last few years, it has been very ably demonstrated by Major Charles E. Woodruff, a surgeon in the United States Army, that light, as well as heat and humidity, has harmful effects upon the white man going to the tropics.[5] He says that this factor must certainly be taken into account when rules for the white man's health in the tropics, are compiled. I will say more of this below.

Huggard, in his article on acclimatization, emphasizes the importance of the age factor when people are attempting to accustom themselves to a new climate. When white children are taken to the tropics they do not stand the change well. If they are brought up from birth there, they are usually delicate; and in a majority of cases they die young. Old people likewise suffer from extremes, but they tolerate heat a little better than children do. Their own heat-producing power being on the decline, cold is a strong depressant, while warmth within reasonable limits is a mild stimulant. It often happens that the first generation going to the tropics may live; but its posterity does not fare well. This is the crucial point of the whole matter.

So far, I have considered the effects of a tropical climate on the individual alone; but if a people are to become acclimatized in a new country we must consider the whole race, and that involves fertility and successful reproduction. For, however well the individual may be enabled, by artificial means or otherwise, to exist, the race will never accommodate itself permanently unless the birth rate exceeds the death rate. At this point, therefore, let us enumerate the precautions that must be taken to insure the life of a white race moving into the tropics; and then we will proceed to a discussion as to whether true acclimatization is possible or not.

First, a change of residence in itself always tends to upset the regular habits of the soldier or colonist. Those who have led temperate lives in the cooler zone are apt to become heavy drinkers in the tropics. So well known is this fact that military authorities of all nationalities who have troops stationed in the tropics place special restrictions on the use of alcoholic drinks. The Portuguese and Spanish races, predisposed to the use of light wines and ready even to give up the habit if need be, suffer from the disorders incident to alcoholism far less than do the English and kindred races. On the other hand, some writers aver that a moderate amount of alcoholic stimulant undoubtedly has a beneficient action.[6] Clarke even asserts that light wine is an indispensable part of a hygienic diet; but the abuse of the drinking habit is a factor in the comparative immunities of all races in the tropics. Nor must the fact be overlooked that alcoholism and sexual immorality go hand in hand.

The subject of acclimatization is complicated by the controls exercised by race, diet, occupations, habits of life, and the like. During the adjustment of white races to the tropics, there is more or less strain on various parts of the body. Care must be taken against too violent exercise; yet some writers advise gentle and regular calisthenics as most advisable.[7] Major Woodruff, on the other hand, advises against regular muscular training, because it produces simply a parasite absorbing nutriment, and is likely to cause a dilated heart.[8] He adds:

"I am much opposed to any calisthenics and outdoor sports which are indulged in for the sole purpose of increasing the muscularity. Athletic contests should be abolished in the tropics."

The ultimate conclusion that one arrives at, after considering all authorities on the subject, is that a small amount of gentle exercise is beneficial, while overexertion of any sort is to be closely guarded against. The adjustment of white races is usually hindered by persistence in habits of food, drink, and general mode of life which, however, well-suited to the home climate, do not fit tropical conditions. During this adjustment, the body is naturally sensitive to the new diseases to which it is exposed. There are anemic tendencies and other degenerative changes. White men cannot do hard manual labor under a tropical sun, but they may enjoy fair health as overseers, or at indoor work, if they take reasonable precautions. Further, all authorities on acclimatization insist upon the precaution of forbidding colonists and soldiers in the tropics to engage in agricultural labor.

One of the deadly diseases common to the white race in the tropics is consumption. Where barbarous races are concerned, their predisposition for this disease often varies inversely with the degree of civilization they have attained. Europeans in their liability to consumption stand halfway between the Mongol and the Negro, and this is another reason why it is dangerous for them to go to the tropics, for it is well known that a tropical climate is fatal to all persons having consumptive tendencies. In fact, they have practically only one way of living there with any degree of safety whatever, and that is, they must live in well-selected hill stations.

Manson is authority for the statement that the longer a white man resides in the tropics, the more he is subject to certain diseases, hough he thinks there is an acquired immunity to typhoid and heat-stroke, the latter being due to greater knowledge and care.[9] As a matter of fact, it has been shown by Firket, Cruikshank and many others that prolonged residence in the tropics does not increase immunity but actually increases our susceptibility, especially in the cases of malaria and dysentery. Therefore, the practical rules for avoiding disease and destruction of health are merely methods of hiding from the known dangers or warding them off. And the best way to keep mortality down is to send the sick home.

In concluding our discussion of the remedies for and preventives of, the injurious influences of a tropic climate, we shall take up the subject of light, as worked out by Major Woodruff in the Philippines. This surgeon, as a result of his observations,[10] has presented a number of rules which are extremely useful. Clothing he rightly asserts should be opaque. The United States soldiers have found the ordinary blue flannel shirt best, as it does not transmit the shorter light waves. It excludes them by "stepping them down" to heat rays, but does not transmit heat as a thin garment does. White outer clothing freely transmits the ray of the sun, thus creating nervous and skin diseases, but if it is used to cover opaque underclothing, the combination is advantageous. "A black negro dressed in white is about as happy and as contented a being as we have in the Philippines." The tendency is to wear clothing which protects against light even less than do our clothes in the temperate zones; that is of course detrimental. For evenings, opacity and reflection of heat are immaterial. Black is best, as it imitates nocturnal animals by keeping in the body heat. At night, moreover, black clothes are actually cooler than white garments of equal weight.

For indoor workers in the tropics, black or dark blue are the coolest colors. Even the Manila policemen have found blue clothes more comfortable where they have an opportunity to stand in the shade. The contrast between being in the shade or in the sunlight is of course the turning point of the whole matter. Even with the best of protection one should avoid as much as possible the direct rays of the sun between 8 A. M. and 4 P. M.

There is a familiar rule in regard to the head and stomach; the former should be kept cool, and the latter, warm. Opaque headgear, with a wide brim and tin-foil lining, is a very essential protection against the direct rays. The hair should not be cut short; this, of course, implies the risk that bald men take when they attempt to live in the tropics. American and European women, too, subject themselves to great danger by insisting upon going without hats. This should never be permitted, and it is always best, where possible, to carry an umbrella.

As to dwellings and buildings of all kinds, it is enough to say that they should be kept dark, as far as possible. So far as I have been able to ascertain, only one person advocates sunlight in tropical houses, and that was to keep out dampness. Large verandas with roofs coming well down toward the ground, are advisable; and house, veranda and all should be raised several feet from the ground. Woodruff says that there is not a residence house in the Philippine Island which is fit for a blond man to live in, and he challenges contradiction.[11] Barracks, public buildings, hospitals—all should be dark inside as well as out.

People employed in offices should not be required to work more than four and a half hours a day, and the best time for this work is between 7 and 11:30 A. M. Otherwise, energies are wasted, the brain becomes inactive and more is lost than is gained. A midday siesta is advisable for civilians and soldiers alike. So universal is the lack of memory, that all individuals required to take examinations should be subjected to them before they go to the tropics, or else, being there they should be sent home to take them, whenever this is possible.

Americans in the Philippines lose energy, strength,

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* Reproduced from *The Yale Scientific Monthly*.

[1] "The Races of Europe," pp. 574–575.

[2] "Influences of Geographic Environment," 1911, pp. 626–627.

[3] Ripley: "The Races of Europe," p. 571.

[4] "Physical and Commercial Geography," 1910, pp. 136–137.

[5] "Effects of Tropical Light on White Men," pp. 321–353.

[6] Ripley: "Races of Europe," p. 562.

[7] *Ibid.*, p. 563.

[8] Major Charles E. Woodruff: "The Effects of Tropical Light on White Men," p. 346.

[9] Manson: "Tropical Diseases."

[10] "Effects of Tropical Light on White Men," p. 123.

[11] *Ibid.*, p. 328.

ambition and notice trivial complaints to which they would give no thought at home. Few men in their third year of continuous service are in their normal healthy condition. This statement is confirmed unanimously by all authorities in the Philippines and on account of its truth, a two-year tour of duty is recommended for the military.

Malaria takes effect in the heat of the tropics when it would be comparatively harmless in temperate zones. For this reason, it is pure murder to set white soldiers at work on roads there. It was imperative that we make *some* roads in the Philippines, but they are without doubt the most expensive ones in our history.

Major Woodruff quotes Dr. Charles F. Harford as saying in a recent number of *Climate:*

"Individuals going to the tropics should be free from bowel disorder, liver trouble, constipation, diarrhœa, or indigestion in any form, seeing that not only are bowel complaints exceedingly common, but malarial fever itself affects chiefly the organs of digestion."

So dangerous is this disease in the tropics that often criminals even have to be sent home for imprisonment.

Physicians now unite almost without exception in opposing the old doctrine that we should eat very lightly of animal foods in the tropics. They call this belief pernicious, as it is now known that natives are suffering from nitrogen starvation; we should not imitate these natives n this respect any more than we should imitate their filthy habits.

Having now become sufficiently familiar with the dangers to which white men are subjected in the tropics, we shall take up the controversy as to the possibility of true acclimatization there. Alfred Russell Wallace favors the true acclimatization theory, either as it involves temperate zone races moving into temperate or frigid zones.[12] He cites several cases to prove the former instance. The Jews, for example, are a good illustration of acclimatization as they have been established for many centuries in climates very different from that of their native land. They keep themselves wholly free from intermixture with the people around them, and are often so populous as to arouse an anti-semitic feeling. Again in some of the hottest parts of South America, Europeans are acclimatized perfectly, and where the race is kept pure it is even said to be improved. For instance, there is a race of people of Spanish extraction who have been living for several centuries in the province of Guayaquil, on the western coast of South America. The white inhabitants of that section are kept so pure by careful selection that even the slightest tincture of red or black blood bars entry into any of the old Spanish families. As a consequence of this careful breeding, the women of Guayaquil are justly considered the finest along the whole Pacific coast. This, and the fact that they are very prolific, is significant in that it shows plainly, the possibility of white men's living in the tropics and perpetuating their race. Another instance which is mentioned is that of the oldest Christian town in Peru—Piura—where the climate is very hot, the temperature rarely falling below 83 deg. Fahr. Yet it is said that people of all countries find the climate healthy there, and the whites have no difficulty in raising good-sized families. And not only are a considerable proportion of the population white, but most of them are descended from the first immigrants after the Spanish conquest. This case again demonstrates the complete acclimatization of Spaniards in one of the hottest parts of South America.

Wallace here admits that many eminent writers have denied this. I shall cite some of these below, in the arguments against complete acclimatization.

In an article which appeared in the *American Anthropologist*"[13] for 1902, J. Elbert Cutler handles the subject from a new point of view. Using Dr. L. W. Sambon[14] as his authority, he points out the absurdity, as he styles it, of many opinions hitherto held in regard to acclimatization in the tropics. He asserts that anemia—one of the diseases common to the tropics—is never caused by heat, as the influence of high temperature causes no change in the proportion of red corpuscles in the blood. He states, moreover, that through bacteriology the parasitic nature of malaria and hepatitis, as well as anemia, has now become recognized.

Continuing, the important points of his treatise are the following: Instead of classing heat exhaustion and thermic fever together under the head of sunstroke, he separates them, calling the former syncope, and the latter sirasis, an infectious disease. Sirasis cannot be due specifically to heat, for the simple reason that our temperate zone workmen employed in turkish baths, mines, and other hot localities, any of which is hotter than the average temperature of the tropics, do not suffer from it.

"It is an interesting fact that the heatstroke, generally so much feared in the tropics, is practically unknown here; men often drop out on the march overcome by heat, but fatal stroke and last heat exhaustion are very rare."[15]

The foregoing statement was made by Col. Charles R. Greenleaf, Chief Surgeon, Division of the Philippines. Dr. Patrick Manson says that heat and moisture are not in themselves the direct cause of any tropical disease.[16] Ninety-nine per cent of these diseases are zymotic and are caused by germs requiring a tropical habitat. Granting this to be true, then it is as possible to combat the microbe in the tropics as in the temperate zones, by sanitation and hygienic precautions.

Cutler now takes up the questions of sterility and degeneration. It has been said that the white race becomes sterile after three generations in the tropics, or if not that absolutely, it degenerates into an inferior one. On these points we have conflicting testimony. As to the latter, Sir William Moore says that he has found tropically-raised children's physique much inferior to that of children raised in England. Dr. Sambon, on the contrary, states that thirty years ago Sir Joseph Fayer conclusively proved that under proper management, children could thrive in India as well as in England. As regards sterility, Ripley concludes that it can neither be affirmed nor denied, from utter lack of evidence.[17] Prof. B. J. Stokvis (Amsterdam) is more sure of himself, saying that in the Dutch West India Colonies pedigrees are to be had of true European families, persisting for almost three centuries without introducing a drop of native blood.[18] Clements R. Markham, Dr. Sambon, Gen. James H. Wilson, and others all give statements based on their own observations opposing the sterility theory.

Ethnic intermarriage between white races and natives is continually being advocated by some writers as a means of acclimatization. In the strict sense of the word it is not acclimatization at all, and the colonies which have succeeded best in the tropics have done entirely without it. Moreover, the Portuguese who intermarried with native women in India have been almost entirely absorbed. This has been due perhaps to the fact that a cross between two races is too often apt to be a weakling, sharing in the tendencies of both parents toward disease, and enjoying but imperfectly their different immunities. All agree that a cross is unfavorable to fertility.

"On the whole," says Mr. Wallace,[19] "we seem justified in concluding that under favorable conditions and with proper adaptation of means to end in view, man may become acclimatized with at least as much certainty and rapidity (counting generations rather than years) as any of the lower animals." Dr. Sambon, too, recognizes the difficulties attending acclimatization; but he thinks that it is within the power of modern science to remove an important section of these difficulties. By classifying heat and disease as two different factors, instead of considering one the cause of the other, he hopes to overcome tropical difficulties with hygienic measures, and not by adaptation. Then, in conclusion, Cutler confidently remarks: "It hardly seems reasonable to dispute any longer the possibility of tropical acclimatization."

If we are to accept his decision as final, there is no more room for dispute; but he has too many points of weakness, and there are too many excellent authorities who hold the opposite view to his, for us to accept his opinion that tropical acclimatization is possible. In the first place, he bases his assertions in too isolated cases. Furthermore, even if the disease theory of Dr. Sambon is correct, its successful establishment will bring about only a state of artificial acclimatization. Cutler himself admits "that artificial adaptation to new climatic conditions is not real acclimatization; but," he continues, "it aids materially in bringing about that result." How is that result, remote in any case, ever to be attained, since its very existence depends upon the constant maintenance of sanitary conditions which may at any time be overthrown by the agency of war, changes in the ownership of land and other means? Cutler has found the former death-rate of European troops in the tropics to be 129 in every 1,000. It is now as low as 12 per 1,000 in India. In Trinidad and Barbadoes sickness and mortality among European soldiers is actually less than at home. These facts are encouraging, but again, they indicate only a state of artificial acclimation supported by sanitation.

I shall now draw upon a few of the authorities—and there are scores of them—who, while they admit the possibility and existence of artificial acclimatization, steadfastly oppose the true acclimatization theory. Major Woodruff's testimony completely refutes most of Wallace's opinions. He says it is a grave error to suppose that white men can ever become acclimatized in the tropics.

"These errors follow from the old idea that, as man was found in every part of the earth which could supply him food, and as he had traveled into every land and sea, it was possible to become acclimated."[20]

Every living thing must remain in its own zone to survive permanently, and if it is taken out of its zone it must be surrounded by artificial conditions which approximate its natural environment or must hide from the dangers against which it has no natural defense. Sanitarians are gradually discovering the causes of the dreadful mortality of white men in the tropics, and are improving conditions so greatly that in some parts, they can live almost as safely as at home. Nevertheless, there is more or less destruction of health even where people do manage to dodge the infections.

"With regard to statements now and then made in medical literature that a tropical climate *per se* is harmless to white men, who can live there for an indefinite period and enjoy good health, we can only say that such writers are wholly mistaken and will change their views after they learn a little more of biology and the facts in the case."[21]

And Ripley aptly says:

"To urge the emigration of women, children, or of any save those in the most robust health to the tropics may not be murder in the first degree, but it should be classed, to put it mildly, as incitement to it."[22]

He adds that it is the height of folly to expect man to compass in a single generation what Nature takes an age to perform.

Another strong argument against permanent acclimatization is afforded us by history. It may be summed up in the well known ethnic law that "intrusive conquest or colonization has left little or no trace," and is borne out by the failure of the Romans' attempt to colonize northern Africa. Rome's work there was wiped out by climatic difficulties.[23] Following the Romans came the Vandals; but they disappeared in the same way. Italy, France and Spain were all once conquered and occupied by Teutonic tribes; but the nations that dwell in these countries to-day are still of Latin origin. Thus, the nations from Southern Europe did not thrive in Africa; those of Northern and Mid-Europe did not thrive in the South; and the tribes of the far North even have difficulty in Sweden and do not flourish there.

Some recent writers are even more conservative than those who wrote twenty or thirty years ago. Prof. Keller states that:[24] "In general, it is only through the exercise of the utmost caution and through the utilization of every means of artificial assistance that even a moderate settlement of whites in hot regions is possible." As time advances, it is always necessary to draw upon the latest resources of modern science in the limitation of natural selection, in order to maintain the life of the individual and the society in tropical lands. "If this is done, the individuals and the race may be to a certain degree and in a certain sense, acclimatized. A sojourn of some years may be managed at an endurable cost."[25] Another authority who is a competent surgeon and has lived much in the tropics, reckons seven years to be the central European's limit of endurance of the equatorial climate, even though he be a strong man living in an island region.[26] It is indeed unfortunate that the very condition necessary for agricultural success in tropical regions—continuous labor—is fatal to white men. For this reason they have always been compelled to depend upon a native labor force in tropical cultivation, the chief products of which are cotton, sugar, and coffee.

Ward is most emphatic in his statement:[27]

"Acclimatization in the full sense of having white men and women living for successive generations in the tropics, and reproducing their kind without physical, mental, and moral degeneration, that is, colonization in the true sense is impossible."

Authorities who agree with the belief might be multiplied indefinitely. Ripley[28] enumerates a good many of them; but it is not necessary to include their testimony, for we have already learned enough about the subject to realize the irrefutable truth of their view.

In closing, a glance into the future may not be out of place. Granting that true acclimatization can never be attained, then the mastery of the rich tropical lands of the world will go to those races which accomplish the most perfect state of artificial acclimatization.

"This means that the conquering white race of the temperate zone is to be excluded by adverse climatic conditions from the productive but undeveloped tropics, unless it consists of hybridization, like the Spainards and Portuguese of tropical America. In that national struggle for existence which is a struggle for space, it means an added advantage for the Mediterranean peoples, that they are more tolerant of a torrid climate than the blond Teutons, whose disability in this regard is pronounced; it means that the aptitude of the Chinese for a wide range of climatic accommodation, from the Arctic circle to the equator, lends color to the 'yellow peril.'"[29]

[12] "Encyclopædia Britannica, 11th, ed., vol. i., p. 118.

[13] "American Anthrop," §4, pp. 421–440.

[14] *Geographical Journal*, 1898, vol. di., p. 589.

[15] "Report of the Surgeon-General of the United States Army," 1901, p. 132.

[16] *British Medical Journal*, 1898, vol. i., p. 1168.

[17] "Races of Europe," p. 580.

[18] "Report of the Seventh International Congress of Hygiene and Demography," 1891, vol. x., p. 185.

[19] "Encyclopædia Britannica," 9th ed., vol. i. p. 90.

[20] "Effects of Tropical Light on White Men," p. 321.

[21] *Ibid*, p. 323.

[22] "The Races of Europe," p. 586.

[23] Huggard, pp. 167–170.

[24] "Physical and Commercial Geography," 1910, p 136.

[25] *Ibid*, p. 137.

[26] Hagen: "Unter den Papua's" (Wiesbaden, 1899), p. 20.

[27] "Climate," 1908, p. 204.

[28] "The Races of Europe," p. 585.

[29] Ellen C. Semple: "Influence of Geographic Environment," p. 628.

A School for

The Newest Departure i

By Dr. Al

The Grounds and Buildings. View from the West

In the Reception Room.

It is strange that the Germans, in spite of their undoubted colonizing capacities, should have achieved so little in the way of actual colonization. German immigrants have, it is true, for centuries past, in this part of the world and elsewhere, done pioneer work in opening up new countries, and sowing on their way the seed of civilization. But this task has been achieved by individuals destined ultimately to become merged with the nation forming the bulk of the population, so that no material benefit was reaped by the mother country, which on the contrary had to sustain a serious loss, being drained of some of her most valuable elements.

Now that the stream of emigration has for some time been practically at a standstill, it is being realized more and more, what advantages could be derived from a well-controlled colonization movement. While England has given birth to a number of thriving commonwealths, reproducing in rejuvenated form the civilization of the country and bringing well-nigh half of the world under Anglo-Saxon rule; while France is fast creating a colonial empire of enormous value, and other nations are in a smaller way seeking an outlet for their surplus populations, together with new markets beyond the seas, Germany has long stood aloof from this struggle for colonial supremacy, contenting herself with a few colonies in a sadly rudimentary state of economic development and governed in a narrow bureaucratic spirit. Nay, until recent times there has even been much prejudice among the stay-at-home elements of the nation against the young man preferring the strenuous life of the pioneer in new lands to a quiet existence in the old country.

Nor had there been until quite recently any special training for German Government officials wishing to enter colonial service, the Colonial Department being content with picking out from each special administrative branch of the Empire and the Federate States, those who on account of their general capacities and their taste for colonial life seemed to offer the best guarantees for efficient work. Jurists having passed their second Government examination, officers, physicians, custom-house officers, and in some special cases, State foresters, would thus be appointed for colonial service. Even at the present day, in that land of "red-tape" there is no question of appointing for any higher posts those having remained outside the pale of officialdom. Though a staff of officials appointed on these principles was bound to bear the stamp of bureaucratism and militarism, it cannot be denied that from its ranks there rose many able men who did most creditable work for the German colonies.

As it is, the Government some years ago started on a somewhat different policy, by organizing a special training course for candidates for the colonial service. These were prepared for their future duties by a most comprehensive curriculum, comprising a long series of special studies and practical apprenticeship at a number of departments, alternately at home and in the colonies, which was concluded by at least one year's stay at the Berlin Seminary for Oriental languages. However, this career, which in spite of the high demands made on candidates and seven years of comprehensive instruction, did not even lead to any higher positions, failed to meet the favor its promotors had anticipated.

In order at last to put an end to this unsatisfactory state of things, and in view of the ever-increasing crowding in many of the ordinary walks of life, a number of noble-minded men some years ago decided on founding a Hochschule where young men chosen from the best elements of the nation, especially sons of landed proprietors, officials, business men, physicians, officers, etc., might be educated for efficient colonial work. This is how the German Colonial Academy at Witzenhausen-on-Werra was called into being.

The Colonial Academy, of course, is mainly destined to train pupils for the various economical pursuits open to the individual colonist. It is true that the instruction there imparted should be supplemented later on by an apprenticeship on the spot, but the training proper is acquired at the Academy itself, with the wonderfully comprehensive resources at its disposal.

This Academy has thus set itself a unique task, which it is rather difficult to appreciate fully. While bearing the character of a German Hochschule, as far as its scientific standard is concerned, it resembles rather an American or English University than the thing commonly thus designated in Germany. In the excellence of its appointments and its width of scope, it stands as a model for others to copy.

If there is a growing necessity for the agriculturist to undergo a thorough training, both theoretical and practical, in special agricultural academies, such a preparatory course is even more indispensable to the settler in overseas countries. While the young farmer at home, moving as he does in a highly developed country, has many opportunities of investigating the vital conditions of his future field of activity, the colonial farmer, in fact, not only meets a state of affairs absolutely unknown to him, but as civilized man, finds himself transferred into economical conditions which are hundreds, and even thousands of years behind those of his own country. This, first of all, presupposes great capacities of adaptation of all his views and ideas, to which effect, a wealth of the most varied theoretical and practical knowledge is required, insuring an intelligent comprehension of the climate, soil, fauna and flora, native populations and their customs, as well as of economical and social conditions. In fact, the more everything in the colonies, especially in an incipient economical development differs from conditions at home, the more the young farmer will have to adapt himself to the most varied conditions and everywhere to shift for himself. While having no experienced neighbors to rely upon for help and no skilled assistants to make up for his own lack of experience, he is bound even to feel more keenly the necessity of amply providing for those little everyday wants for which thousands of helping hands and machines, manufacturers and middlemen had been continually at his disposal in the old country. This is why the colonial farmer, apart from his agricultural capacities, must be a Jack-of-all-trades.

In spite of its mediaeval surroundings, the new Institute is thoroughly modern in its spirit, and adapted to the requirements of present-day colonial politics. While in olden times young generations possessing all the qualities and capacities of the "settler" sprang up naturally, under modern conditions, over-civilization and a growing estrangement from the simple and natural life of the agriculturist and artisan have now to be counteracted if the nation is really to become fit for colonization work.

Another task before the founders of the Colonial Academy was to supplement the home industry, trade and agriculture, by opening up and developing over-sea countries, studying the requirements of tropical climates and educating the native populations to a better appreciation of their own life-interest, both from an economical and moral point of view.

Good care has been taken to avoid the pedantism and red-tape only too often characteristic of German educational methods. Rather than to cram the pupils' heads with much useless stuff the endeavor has been to train and test their minds and characters.

Students at Work in the Hay Fields.

for lonial Science

arture i man Educational Work

Dr. Al radenwitz

The Colonial Academy comprises a farm belonging to a rmer royal domain, now fitted up especially for its esent purpose, the extensive buildings of an old Wilhel-ite Convent and the one-time custom-house. This oup of houses, situated immediately on the banks of the er, near the gates of the town, has been supplemented spacious new buildings with large gardens. The class d dwelling rooms of the pupils are located in the Con-nt itself, which is a horse-shoe shaped building. A ge annex in modern Gothic style, adapted to that of e old building, is an architectural curiosity in itself.

Extensive conservatories, especially for economic opical plants, a laboratory and collection rooms, all nds of workshops, a dairy operated by a special water-wer plant, a model dairy-stable and a large riding hall d gymnasium, etc., supplement the appointments of e Academy. Vast fields (about 650 acres), surrounding ewly established farm, allow agriculture and stock-ming to be studied under their most varied forms. Comprehensive gardens, including large nurseries ,000 saplings), fruit-tree plantations (5,000 trees), eyards, tobacco plantations and woodlands for the dy of forestry, afford additional means of instruction. oreover the tobacco and preserve factories of Witzen-usen, the surrounding State Forests and especially the resters' Academy at Muenden, the proximity of Cassel h the Wilhelmshoehe Gardens, as well as of Goettin-University, furnish ready means to supplement the ources of the Academy in every way.

The main feature of the Colonial Academy is an har-nious combination of careful theory and extensive ctice. Just as the future officer has to go through n the smallest and most menial exercises of the private dier, the young man devoting himself to colonial work st become proficient in every detail of practical agri-ture, gardening and the most important trades. So from dabbling in a desultory way, with these different nches of practical knowledge, every pupil therefore dergoes a thorough apprenticeship in each of them. ose same young men who have spent their mornings ening to lectures on the most serious scientific prob-s, including the study of the soil and plant structure, rganic chemistry, evolution, animal dietetics and man hygiene (especially hygiene of the tropics), botany tropical forests, civil engineering, technology, forest nagement, commercial science, colonial politics, eth-graphy, national and colonial economy, history of gion and colonial law, these men may be seen in afternoon engaged in practical work, digging, spread-manure, pitching hay, harvesting, etc. When ap-nted for service in the smithy, the cartwright's shop, bricklaying and other trades, in the nursery or vine-rd, in surveying or drawing or in the practical exer-es of the chemical laboratory, they are strictly required go through every detail of work, be it interesting or some. While they may on the one hand be tending the conservatory the most delicate plants, they are led upon on the other hand to go through every detail nected with coarser work, as for instance in the dairy, milking of cows or the cleaning of stables.

Such leisure time as is left by so comprehensive a gram is given up to optional sporting exercises on d and water, including gymnastics, lawn tennis, row-and fencing, boat building and shooting, while the tivation of music and extensive tours by foot or by eel through the beautiful surroundings round off the istic side of college life at Witzenhausen.

This comprehensive day's task is gone through within e quaint surroundings of a vast monastery, close to the ny banks of the Werra, in the midst of the delicate auty of scenery of the Thuringo-Hessian mountains. e German Colonial Academy forms a small town in lf, with its many buildings and manifold courtyards d gardens. On one side of the convent, which contains class and dwelling rooms, are found all sorts of farm uses and workshops, the dairy, the mill and cow stable, riding hall and gymnasium, laboratories and scientific binets, as well as the conservatories. Another addition special economic importance is a model farm situated tside of the town where farm horses, colts, milch cows d cattle, sheep and pigs are reared.

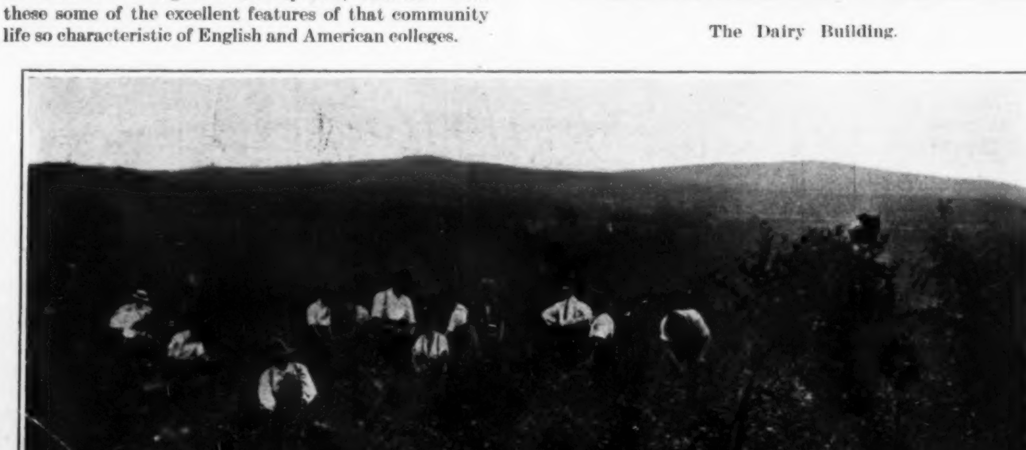
A recent addition is a Colonial Museum, the collections which are donations by friends and former students of e Academy. The ethnographical exhibits, arranged in graphical order, are especially noteworthy. The aining rooms of the Museum are filled up with a dily increasing wealth of zoological objects, such as s, horns, bird-skins, and collections of tortoises, in-ts, beetles and butterflies. These obviously enable a re adequate idea of any given over-seas districts to be tained, with its native population—its life, customs d means of livelihood—the animal life characteristic of the country and the activities of the white element.

A Picturesque Corner in the School Grounds.

Life at the Colonial Academy—as controlled by a code of private regulations—is hardly comparable with that of any other German educational institution, apart, possibly, from military academies. In fact the English-American collegiate system, which has been chosen as a model in drawing up the constitution of the Colonial Academy, was, so far, practically unknown to German students. The advantages of this system in the interest of a steady, well-arranged work, as well as the formation of virile characters, seemed of such paramount importance to the founders of the Colonial Academy, that they did not hesitate to adopt it with a view not only better to perform each day's task, but to be able more adequately to train and test the character of students, by allowing them to form a little community of their own, endowed with extensive autonomy.

Germany has long led the world in the educational field. Its schools, especially in the higher departments of learning, are a model for all the world. Its universities retain upon their teaching staff some of the greatest celebrities of our day. There is practically no department of academic learning in which Germany does not stand in the very front rank. One might perhaps think that with such a highly developed system, which by now has settled along well established lines, there might be some danger of falling into a stereotyped form and a lack in progressiveness. Indeed, if we wish to be critical, possibly we might point to this or that feature in the German system, in which we feel gratification in reflecting that our American system, or perhaps the English system, offers advantages over the German. But the strongest point in the situation is the fact that the Germans themselves recognize any such shortcomings in their system and do not allow themselves to be blinded by the truly admirable standard which they have achieved. The present departure, of which an account is here given, is perhaps as good an example as could possibly be given of this progressive spirit in German educational affairs. While the enterprise is distinctly original and does not seem to be duplicated anywhere else in all the world, the founders have thought it fit, in certain respects, to imitate the Anglo-American system. Thus this new branch, grafted upon the sturdy tree of German university activity, while, on the one hand, bearing all the characteristics of German thoroughness and system, combines with these some of the excellent features of that community life so characteristic of English and American colleges.

The Dairy Building.



Students at Work in Practical Horticulture.

International Aviation Cup Defender Design*

Computation of the Principal Features

By E. R. Armstrong

In the design of an aeroplane, five different quantities must be considered, the speed through the air, total weight in order of flight, power required, surface of support and head resistance including skin friction. To arrive at the correct relationship of these elements that the design must have in order to produce an aeroplane capable of the highest speed, is the problem under consideration.

The speed attained in the last Gordon-Bennett race was about 80 miles per hour. Recently the world's record was broken when the speed attained was more than 93 miles per hour, with a 70 horse-power motor.[1] There is no reason to doubt the assumption that the winner of the next race must be able to exceed a speed of 100 miles per hour. As a starting point in the design, it is necessary to assume that the proposed machine shall have a speed of at least 110 miles per hour.

The efficiency curves as given by Eiffel for the different wing areas and sections of the Blériot, Nieuport, Tatin, Breguet and R. E. P., show but a small variation, hardly more than 15 per cent difference between the least efficient and the best. That is to say, when these different wing sections are compared, they will lift about the same with equal head resistance, although they may be traveling at different speeds and have different angles of incidence. Generally speaking, the higher the speed the less the camber of the wing and angle of incidence necessary for support, so that the higher the speed the less power required for support. This is clearly shown in Fig. 3 on the design chart by curve No. 1, where the resistance of the planes becomes less and less as the speed is increased. The great difference in speed of the different machines, in relation to horse-power, is generally the difference in the head resistance.

Fig. 2 shows the lift and drift of the section adopted as the most suitable for the present design, the results being given in pounds per square foot at a speed of one mile per hour.

From existing machines it is estimated that at a maximum, the total weight of the machine, with pilot and fuel necessary for a flight of 1½ hours, will not exceed 1,100 pounds. The maximum loading per square foot is assumed to be 10 pounds which gives as the total area of the main planes 110 square feet.

Fig. 2 shows that the maximum angle of incidence possible with the type of wing section adopted is 15 degrees, at which angle the lift is 0.0024 pounds per square foot. It is now necessary to know what is the minimum speed that will give a support of 10 pounds per square foot. When 0.0024 is multiplied by such a multiplier of Fig. 1 that the result is equal to 10, then the

Speed in miles per hour.	Multiplier.	Speed in miles per hour.	Multiplier.	Speed in miles per hour.	Multiplier.	Speed in miles per hour.	Multiplier.
1	1	26	676	51	2,601	76	5,776
2	4	27	729	52	2,704	77	5,929
3	9	28	784	53	2,809	78	6,084
4	16	29	841	54	2,916	79	6,241
5	25	30	900	55	3,025	80	6,400
6	36	31	961	56	3,136	81	6,561
7	49	32	1,024	57	3,249	82	6,724
8	64	33	1,089	58	3,364	83	6,889
9	81	34	1,156	59	3,481	84	7,056
10	100	35	1,225	60	3,600	85	7,225
11	121	36	1,296	61	3,721	86	7,396
12	144	37	1,369	62	3,844	87	7,569
13	169	38	1,444	63	3,969	88	7,744
14	196	39	1,521	64	4,096	89	7,921
15	225	40	1,600	65	4,225	90	8,100
16	256	41	1,681	66	4,356	91	8,281
17	289	42	1,764	67	4,489	92	8,464
18	324	43	1,849	68	4,624	93	8,649
19	361	44	1,936	69	4,761	94	8,836
20	400	45	2,025	70	4,900	95	9,025
21	441	46	2,116	71	5,041	96	9,216
22	484	47	2,209	72	5,184	97	9,409
23	529	48	2,304	73	5,329	98	9,604
24	576	49	2,401	74	5,476	99	9,801
25	625	50	2,500	75	5,625	100	10,000

Fig. 1.—Table of Multipliers to be Applied to Lift and Drift at a Speed of One Mile Per Hour, to Obtain the Lift and Drift at Any Other Stated Speed.

speed opposite such multiplier is the slowest speed possible for the proposed monoplane. In the case under consideration the speed is found to be about 65 miles per hour.

It is now necessary to lay out the design chart illustrated in Fig. 3, to show the different resistance and power curves in such a way as to keep clearly in mind the various factors and their bearing on the whole design. The first curve to draw on the chart is the curve showing the plane resistance (curve No. 1) showing as it does the head resistance of the main planes at different angles of incidence and such speed in miles per hour that will give a support of 10 pounds per square foot for a total area of 110 square feet.

At 15 degrees the drift is 0.00057 pounds per square foot which, when multiplied by 4,225, the multiplier of 65 miles, gives the resistance of 2.408 pounds; this multi-

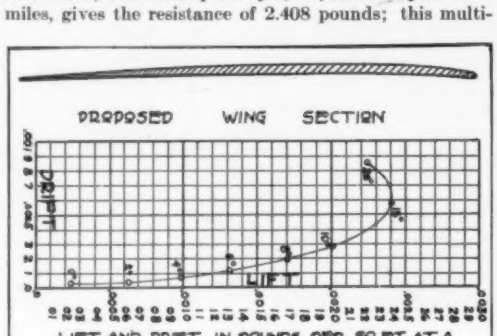


Fig. 2.

plied by 110, the number of square feet in the planes, gives as the total resistance of the planes at the speed of 65 miles per hour, 265 pounds. The lift at ten degrees is 0.00202 pounds with a drift of 0.00028 pounds. Ten divided by 0.00202 equals 4,950, multiplier of about 70 miles; 4,950 multiplied by 0.00028 and the result multiplied by 110 gives 151, the resistance of the planes at 70 miles per hour at an angle of 10 degrees, at which speed the support will be 1,100 pounds. Proceed in this manner and calculate the resistance for the different speeds up to 120 miles, as shown in the aeroplane chart, Fig. 3.

It has now been determined that, for a speed of 110 miles per hour, 110 square feet of surface is necessary to support 1,100 pounds at an angle of incidence of about 3½ degrees. To support this weight, at that speed, will require about 30 horse-power, if an efficiency of 70 per cent of the propeller is assumed. If the horse-power required for flight were only necessary to support the weight, speeds of 200 miles per hour would appear feasable, as the actual power necessary for support decreases with the increase of speed. Increase in speed is only a matter of decreasing the head resistance of the body and other essential parts of the machine. In the past the body design has been made to conform to the shape of the motor, and in almost every case is much larger than that necessary to contain the aviator and all controls. In the present design the cross section of the body is that necessary to contain the aviator, the motor and all accessories being so located in the same body as not to set up any additional head resistance. Such a cross section of the body will be the least possible for any aeroplane, as the dimensions adopted are based solely on the size of the pilot.

Fig. 3 shows the plan, elevation, and side view of the design. No attempt is made to show the structural features, as the present article has to do only with the size and arrangements of the different elements of the aeroplane. It is now necessary to estimate the head resistance of the different parts of the design as shown in Fig. 3. This is done by taking each exposed surface separately, correcting for shape and length to breadth ratio, and adding them all together to represent the total head resistance of a single surface, placed normally to the line of flight. The resistance, on calculation is found to be equivalent to less than four square feet of normal surface.

Using this amount as the area of head resistance, the resistance at the different speeds is calculated. The results are shown on the design chart by curve No. 2, Fig. 3. This curve shows the total head resistance of the machine, other than the plane resistance. The plane resistance is added to the body resistance, giving the total resistance as shown in curve No. 3. The chart also illustrates the speed of flight in feet per minute. If the resistance in pounds, at a given speed in miles per hour, is multiplied by the equivalent speed in feet per minute and the result divided by 33,000, it will give the necessary horse-power required at that speed. This has been done for the different speeds and resistances and is shown in curve No. 4, as the horse-power required. From this curve it is seen that about 65 effective horse-power is required to maintain a speed of 110 miles per hour. If an efficiency of 70 per cent is assumed for the propeller, at least 93 horse-power will be necessary for horizontal flight. In order to have a reserve of power and provide for climbing, a motor of at least 120 horse-power should be used. Assuming that the motor selected will give that power at 1,200 revolutions per minute and that its power is proportional to the speed, the horse-power available is next plotted by taking the power at a given number of revolutions. Correcting for the assumed slip of the propeller at that speed, will give the speed of advance at the number of revolutions considered, the power being corrected for the efficiency of the propeller. For instance, at a speed of 1,000 revolutions per minute, the power of the motor will be 100 horse-power, which, at 70 per cent efficiency, will be 70 effective horse-power. The propeller is 8 feet 6 inches diameter with a pitch of 11 feet 6 inches, of which the assumed slip is 28 per cent, so that the speed of advance will be 11,500 feet, less 28 per cent, which gives 8,280 feet as the speed of advance, or 94 miles per hour. At this speed the motor and propeller will be giving 70 effective horse-power. Proceeding in this manner, the effective horse-power curve is drawn for different engine speeds up to and including 1,300 revolutions per minute. This curve is shown as No. 6 in Fig. 3.

Curve No. 5, showing the gliding angle, is next plotted. This curve shows the gliding angle in degrees and as a ratio of the distance descended to the distance traveled in a horizontal direction. It is obtained by dividing the total weight by the total resistance at the different speeds, and shows the best possible gliding angle for the different speeds. The curve shows the best gliding angle to be about 9½ degrees, at a speed of 85 miles per hour. The chart also shows that, at a speed of about 95 miles per hour, there is a reserve of about 25 horse-power, which will permit a climbing rate of about 700 feet per minute. The chart further shows that the proposed design should give the extreme speed of 120 miles per hour.

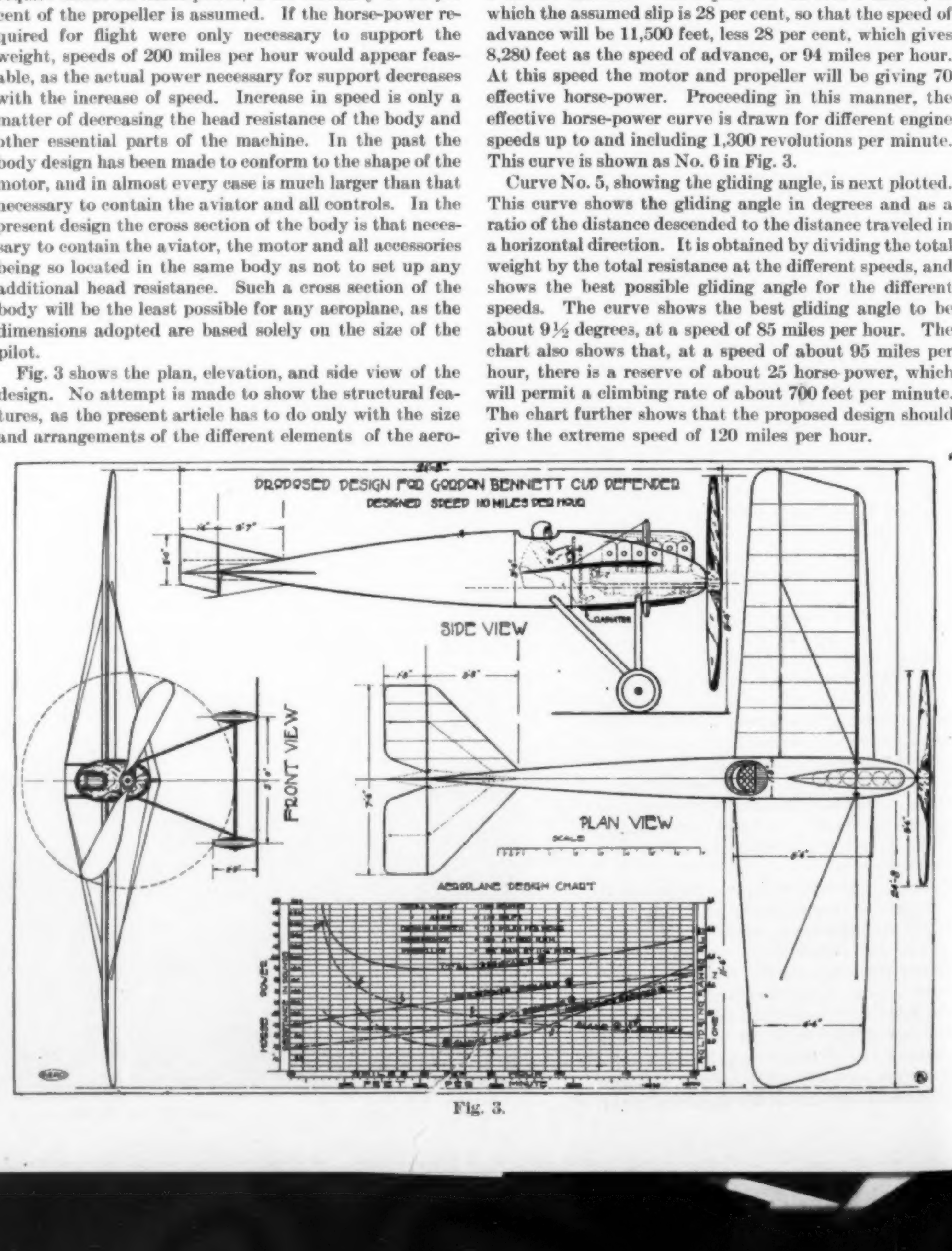


Fig. 3.

[1] At Pau, on March 2nd, Jules Vedrines, on a 140 H. P. Gnome-engined Deperdussin monoplane, covered one circuit of a 10-kilometer (6.21-mile) course in 3 min. 34⅘ secs., equivalent to a speed of 104.33 miles an hour. This is the record at the present time. The Paulhan-Tatin torpedo monoplane, with propeller at the rear end of the body, is credited with a speed of 94 m. p. h. with a 50 H. P. Gnome motor.

Internationalism in Science

A Movement for Centralization

One of the circumstances which give man an immense advantage over the other biological species in the struggle for existence is the fact that the experiences of each generation are handed down for the benefit of the descendants, who thus start out upon life at an advantage, as compared with their progenitors. While this factor must have been at work in the evolution of the human race from the gray dawn of its history, when all tradition was necessarily oral, its significance must have grown by leaps and bounds, first with the invention of the art of writing, which gave man the means of keeping a permanent record of events; later with the introduction of the printing press, the greatest of all disseminators of human knowledge; and last of all with the development of the modern method of systematically recording and spreading broadcast the results of current scientific investigation. And have we then arrived at the last and final stage of development beyond which further improvement is unthinkable?

Science is essentially international. Yet the administration of specific international affairs in science has hitherto been left largely to chance organizations, which, like mushroom growths, have arisen as occasion demanded to meet the exigencies of the day. Here and there permanent international committees have been appointed, it is true, to deal with certain special matters, such as the establishing of standard atomic weights and the like. But a permanent head to regulate and properly co-ordinate all such efforts has been lacking. International congresses have been convened by the representatives of every branch of pure and applied science, and have for the most part been conducted to the satisfaction of all concerned. But each congress had, so to speak, to work out its own salvation. It was not in any definite and systematic way linked with previous congresses, by a detailed record of the experiences by which it could profit. This is all the more serious because in most instances international congresses occur only at rather long intervals, and it is very improbable that the men who were the leading spirits in the management of one such congress, held say at Washington, will live to hold the same office at a subsequent congress of the same kind convened in the same locality.

If things have been done well there are those who think they might have been done better, had there been some central head supervising and exerting a guiding influence. As a concrete example of the need of some such guidance may be quoted the meeting of the permanent Commission of International Congresses of Electrology and Medical Radiology which met at Barcelona from September 13th to 18th, 1910, while from the 13th to the 15th of the same month of the same year the International Congress of Radiology and Electricity met at Brussels. Such clashing of the meetings of bodies devoted to similar interests should be avoided, and all duplication of work and discussions could, under proper management from some central bureau, be reduced to a minimum. Questions of international etiquette, too, which are apt to arise in connection with the holding of great international conventions, can, as a rule, be disposed of with greater delicacy and less offence to those concerned, by an entirely neutral body, than by a necessarily national administrative board taking care of the local arrangements for the congress.

A good idea of the extent to which international activity in science has grown is obtained from a perusal of Dr. Eijkman's publications, *L'Internationalisme Scientifique* and *L'Internationalisme Médical*. The former lists no less than 614 international congresses, committees and associations devoted to the promotion of one phase or other of scientific work.

As the readers of the Scientific American Supplement may be expected to take a special interest in technological subjects, a list of some special bodies and conventions past and future devoted to work along this line is appended at the end of this article.

An effort has been made to centralize all international affairs in science by the promotion of the International Association of Academies, whose headquarters are at St. Petersburg. The association includes the Dutch Academies of Science (Amsterdam), the Academies of Prussia (Berlin), Switzerland (Basle), Belgium (Brussels), Hungary (Budapest), Norway (Christiania), the Royal Academy of Science, Göttingen; the Danish Academy of Sciences at Copenhagen; the Saxon Academy of Science, Leipzig; the British Academy, London; the Royal Society, London; the Royal Academy of Sciences at Madrid; the Royal Bavarian Academy of Science at Munich; the Academy of Inscriptions and Belles Lettres, Paris; the Academy of Science at Paris; the Academy of Moral and Political Science, Paris; the Imperial Academy of Science in St. Petersburg; the Royal Academy of Science at Rome; Royal Academy of Science, Stockholm; the Imperial Academy of Science, Tokyo; National Academy of Sciences, Washington; the Imperial Academy of Sciences, Vienna.

This Association of Academies has drawn up quite an extensive programme of work to be taken care of under its auspices. Among the items may be picked out just a few which are of the greatest interest, as follows:

The preparation of an international catalogue of scientific literature.

International co-operation in the observation of earthquakes.

The study of electric phenomena of the atmosphere.

An international campaign against diseases of cultivated plants.

Index of historical, philological and social publications.

The association is also in constant relation with the following institutions, among others:

Central Committee for Research Work on the Brain.

Commission for Lunar Nomenclature.

International Union for Solar Research.

Commission for the Annual Publication of Tables of Physical and Chemical Constants.

While this association of academies is in some respects an ideal body for dealing with international affairs in science, it labors under several disadvantages. In the first place it has no definite and permanent building in which to locate its headquarters. In addition to this the scope of the association, although very broad, is, after all, more limited than that taken in view for the foundation for internationalism, which proposes to establish a number of bureaus devoted to the several branches of international life. The Bureau of Pure Sciences, in particular, is planned on the broadest possible basis to take care of every phase of international life in science. It is intended to furnish not only that supervision and guidance of which mention was made above for the convening of congresses in all branches of science, but it is furthermore to function as permanent headquarters, at which work shall be carried on also during the interim between congresses, and where records of every kind may be kept and made accessible to inquirers.

This movement is receiving the support of many of the foremost men of science abroad and in this country, among whom may be mentioned the names of Arrhenius, Bertillon, Ehrlich, Emil Fischer, Lockyer, Metchnikoff, Ostwald, Ramsay, Roux, Rübner, Schuster, Waldeyer, J. McKeen Cattell, Harvey Cushing, George E. Hale, W. C. MacCallum, S. N. D. North, Henry Fairfield Osborn, E. C. Pickering, Ira Remsen, and Charles Baskerville.

Dr. Eijkman, director of the foundation, is at the present time visiting the United States and is stirring up interest in the matter. The movement is one of extreme importance, and deserves the hearty support and co-operation of all scientific men, and it is to be hoped that it will make rapid progress to a stage in which the foundation will be in a position to fulfill effectually its high function.

LIST OF SOME OF THE CHIEF INTERNATIONAL CONGRESSES, COMMISSIONS AND COMMITTEES.

International Bureau of Weights and Measures, Pavillon de Breteuil, Sèvres, France.

International Institute for Technobibliography, Spichernstrasse 17, Berlin W. 50.

International Association of Refrigeration, 10 Rue Denis Poisson, Paris.

International Conventions on Electrical Units (1882, Paris; 1884, Paris; 1905, Charlottenburg; 1908, London).

International Congress of Gas Manufacturers, 1900, Paris.

International Commission of Photometry, Secretary General, M. Ph. Delahaye, 105 Rue St. Lazare, Paris.

International Congress of Electricians (1881, Paris; 1889, Paris; 1893, Chicago).

International Congress of Electricity (1891, Frankfort; 1896, Geneva; 1900, Paris; 1904, St. Louis).

International Congress of Applied Electricity (1908, Marseilles).

International Congress of Radiology and Ionization (1905, Brussels).

International Electro-technic Commission, Secretary General, M. C. LeMaistre, 28 Victoria Street, Westminster, London, S. W.

Permanent Commission of the International Congresses of Applied Chemistry, President, Prof. Dr. A. F. Holleman, Oosterpark 59, Amsterdam.

International Association of Chemists of the Leather Industry, General Secretary, Prof. Dr. Edmund Stiasny, 8 Monkbridge Road, Headingly, Leeds.

International Commission for the Standardization of Sugar Analyses, M. François Sachs, Rue de Longue-Vie 64, Brussels.

International Commission for the Standardization of the Examination of Petroleum Products, Dr. Leo Ubbelohde, Karlsruhe.

International Commission for the Standardization of the Examination of Fats, Dr. Leo Ubbelohde, Karlsruhe.

International Rubber Testing Committee, President, Dr. A. H. Berkhout, Wageningen.

International Congress of Sugar and Fermenting Industries (1905, Liège; 1908, Paris.)

International Committee of Carbid and Acetylene, 104 Boulevard de Clichy, Paris.

International Association for Testing Materials, General Secretary, Ernst Reitler, Nordbahnstrasse 50, Vienna II.

Permanent Petroleum Congress, Secretary, Albert Blazy, Place des Vosges, Paris II.

International Congress of Mineral Waters (1910, Brussels).

Permanent Commission of International Congresses of Photography, 51 Rue de Clichy, Paris.

International Photographic Union, 25 Rue Rembrandt, Antwerp.

International Congress for Applied Photography, (1909, Dresden).

International Geologic Congresses (1913, Canada).

International Congress of Mines and Metallurgy, Mechanics and Applied Geology (1915, London. G. C. Lloyd, Secretary Iron and Steel Institute, 28 Victoria Street, London, S. W.).

Association of the Congress of Mining Properties, etc., 4 Rue Basse, Lille.

International Agro-geological Conventions (1914, St. Petersburg. Alexandre Karpinsky, Quai Nicholas I, St. Petersburg).

Permanent Committee of the International Congresses of Architects, Secretary, M. Poupinel, Rue Boissy d'Anglais 45, Paris.

International Congress of Food Hygiene (1906, Paris; 1910, Brussels).

International Opium Commission (1909, Shanghai; 1910, The Hague).

International Commission for the Study of Occupational Diseases (1906, Milan; 1910, Brussels).

International Congress of Workmen's Dwellings (1910, Brussels).

International Commission for Preparing International Congresses for Hygienic Reform in Dwelling Houses, Dr. F. Marie-Davy, 5 Avenue d'Orléans, Paris XIV.

International Congress for the Promotion of Cremation (Brussels, 1910).

Conference for Combating Unnecessary Street Noises, (1910, Berlin; 1912, New York).

International Congress of Life Saving (1889, Paris; 1900, Paris; 1904, Paris).

The Length of Life of Animals

Some very interesting facts are quoted in a recent number of *La Nature* from a paper read by Dr. Mitchell before the London Zoological Society. Dr. Mitchell has been collecting data regarding the length of life attained by various animals under observation at the London Zoological Gardens. Animals in captivity are usually rather short lived in spite of the special attention and precautions taken for them; in fact, as compared with most animals, man occupies a very favorable position in respect to longevity.

Lions have a mean length of life of 30 to 40 years. One polar bear lived in the zoological gardens for a period of 33 years. The oldest among the hoofed tribe may attain some fifty years or so. In the popular mind there is a common impression that whales and elephants attain a very advanced age. As regards whales the zoological gardens have no observations available. With respect to the elephant, however, it appears that the common impression is an exaggeration. Dr. Mitchell thinks that 100 years represents an extreme limit, and that the usual length of life is about 20 to 30 years.

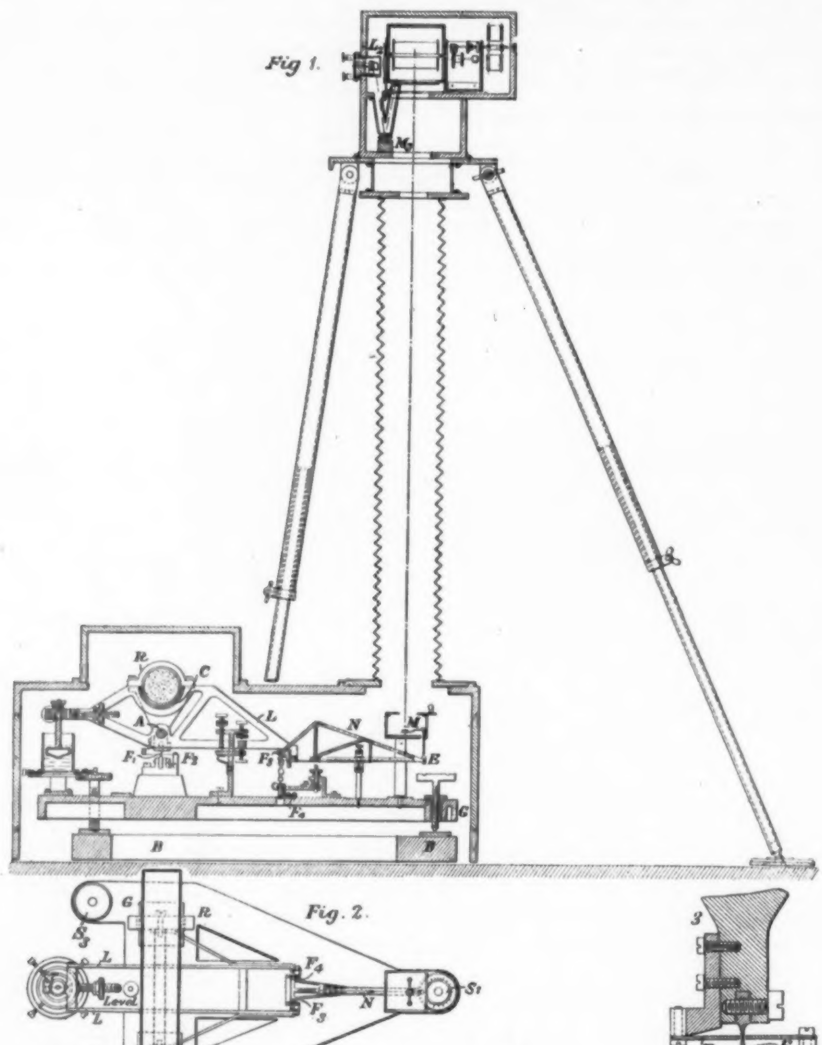
Birds are comparatively long lived. A raven reached the age of 69, and an eagle 68; a parrot exceeded a century. Ostriches seem to reach only about 35 years as a maximum. The hardest mammals to keep alive in captivity are bats. The maximum for these at the gardens is only eleven months. This is due, not to any natural limitation of their life, but to their extreme sensitiveness to the artificial conditions under which they live.

New Seismometers

Some Records of "Artificial Earthquakes"

At the Bochum mines there has been established a magnetic observatory and earthquake station the equipment of which, as described in *Engineering*, may be taken as a model of its kind.

The object of the earthquake station is to observe and to record the phenomena of natural and "artificial" earthquakes and to study them in their bearing upon mining. The term "artificial earthquakes" may be used to indicate all concussions of the earth produced indirectly by human agency; by traffic, machinery, blasting, etc. So far as we know, the magnetic observatory and earthquake station at Bochum are the only ones especially equipped for the systematic study of these phenomena in the interest of the miner. Aachen is similarly equipped, but artificial earthquakes are not studied there. That the continuous control of the magnetic elements is of great importance to the miner, need not be pointed out. In how far the study of earthquake phenomena can be of direct utility to him, the future will teach. But the provision of a suitable observatory for both these purposes in connection with the practical miners' schools of the Berggewerkschaftskasse has generally been welcomed. The Berggewerkschaftskasse is a common fund, to which all the mine proprietors of the district have to contribute. Prof. F. Heise is the director of the schools, and Dr. L. Mintrop is the chief of the observatory department and originator of several of the instruments used in it. We now propose to describe the seismographic equipment and some of the results obtained with it.



The Wiechert Mintrop Seismometer-Pendulum. Fig. 1, Vertical Section. Fig. 2, Plan. Fig. 3, Spring Suspension.

The equipment consists, in the first instance, of three astatic Wiechert pendulums, two suspended so as to record the horizontal components, one for registering the vertical component, all mechanically recording with the aid of styles on drums. The "stationary masses" of these horizontal pendulums weigh 1,000 kilogrammes and 200 kilogrammes; that of the vertical pendulum weighs 1,300 kilogrammes. Prof. E. Wiechert of Göttingen has a preference for heavy pendulums and for large magnifications by means of lever systems. In England the simple light boom pendulum, not provided with special appliances for magnification, of Dr. J. Milne enjoys general favor. There are further at Bochum two portable horizontal pendulums, each for two components, of the Rebeur type, constructed to the designs of Dr. Mintrop, for recording gradual level changes and inclinations and depressions caused by excavations in mines. The two pendulums weigh 15 kilogrammes each; the one is suspended by springs, the other between points, and the deflections are magnified ten or twenty times. The third set of instruments comprises two highly sensitive portable seismometers for photographic records, the one a horizontal pendulum of the Wiechert-Mintrop type, the other a universal pendulum of Dr. Mintrop. The latter instrument records on the same film the two components of the horizontal movement and the vertical movement; its direct mechanical magnification is about 500 times, but with the aid of mirrors the magnification can be raised to 16,000, as in the former case. The periods of the three pendulums of the universal instrument are 0.24, 0.18, 0.24 second (vertical), the period of the horizontal pendulums is 0.7 or 1.0 second. We illustrate these last two instruments herewith.

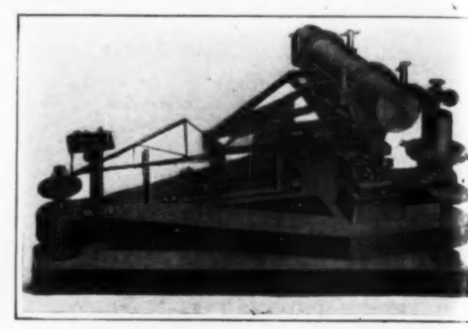


Fig. 4.—View of Seismometer With Recording Apparatus Removed.

The horizontal Wiechert-Mintrop pendulum (Figs. 1 to 7) consists of the seismometer proper and the recording apparatus, which is mounted above the seismometer and connected with it by bellows. Fig. 1 is a vertical section through the whole instrument; Fig. 2 is a plan; Fig. 4 a view of the seismometer, with the recording appliances and the whole outer casing removed. The seismometer rests with three strong screws S_1, S_2, S_3 on a solid iron base-plate B which is rigidly attached to the ground; B is triangular in shape and has a length of about 11 inches. The screws support the iron frame G. The stationary mass, the pendulum, is a cylinder of brass filled with 12 kilogrammes of cast lead. This cylinder lies in a split cylinder C (see Figs. 1 and 2) which is supported by two pairs of half rings R, R. The split cylinder forms a connection between the lower members of the ring supports, which are further joined by the strong axis A (Fig. 1). The whole system is carried by the two flat springs F_1 and F_2, which cross one another at right angles; these parts, which correspond to the pivot of the movable system, can better be seen in Fig. 3. The oscillations of the pendulum are taken up by the brass rods L and transferred by a double system of cross flat springs F_3, F_4 (see Fig. 5), to the aluminium lever N. The lever N is itself supported at the one end by a vertical flat spring P_2, which is fixed in the small column Q; this column is vertically adjustable, and forms the head of another flat spring P_1. Figs. 1 and 3 further show the dashpot, which is filled with oil; the damping ratio is 3 : 1.

The instrument acts in the following way: The base B and the frame G participate in the oscillations of the ground, but the heavy mass of the pendulum

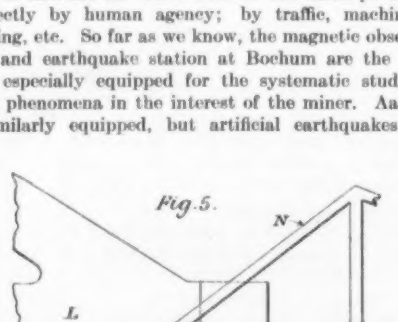


Fig. 5.—Spring Suspension of the Aluminium Lever N.

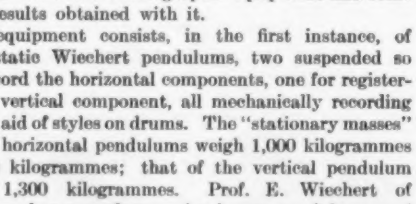


Fig. 6.—The Reflecting Mirror and Its Suspension.

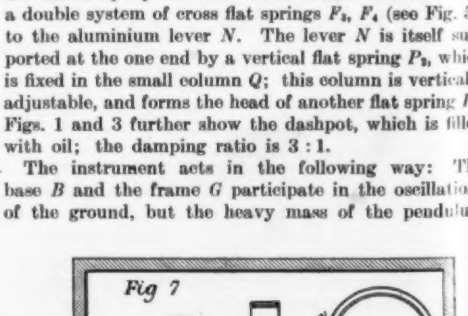


Fig. 7.—Photographic Recorder.

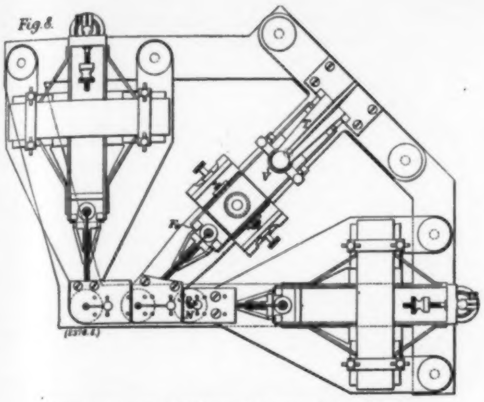


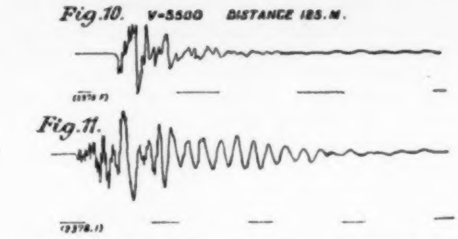
Fig. 8.—The Mintrop Universal Pendulum.

is too sluggish, and as a result the pendulum will appear to move in the opposite direction to the framing. The levers L and N will therefore turn, and the originally horizontal movement of the ground will be changed into a vertical movement of the point E (Fig. 1) and at the same time be mechanically magnified 40 times. A further optical magnification will take place at the point E by the concave mirror M, which is mounted on steel points resting on the agate cups of two little pillars fixed to a table which stands directly on the framing G (Fig. 1). The mirror is tilted through the intermediation of a rod which rises from the end of the aluminium lever N; this rod extends through a perforation in the little table and is crowned by a third agate cup, from the steel point of which a small lever reaches over to the mirror. Fig. 6 shows details of this table. Instead of the one pair of pillars just mentioned, four pairs will be seen, in addition to the last-mentioned odd cup; the four pairs are at 5 millimeters, 10 millimeters, 20 millimeters, and 40 millimeters from the odd cup, and by their aid the magnification can be varied in wide limits, roughly from 2,000 to 16,000 times. The actual magnitudes of the earth's movement cannot directly be deduced from these magnification co-efficients; for they depend also on the inertia of the masses, and have to be determined by calculation and experiment. In order to facilitate the latter determination the screw S_1 (see Figs. 1, 2, and 4) is provided with a fine thread, and its head is divided; the screw is turned through a definite angle, producing a certain tilt of the instrument, and the corresponding mirror deflection is read off; the screw is therefore called the "inclination screw."

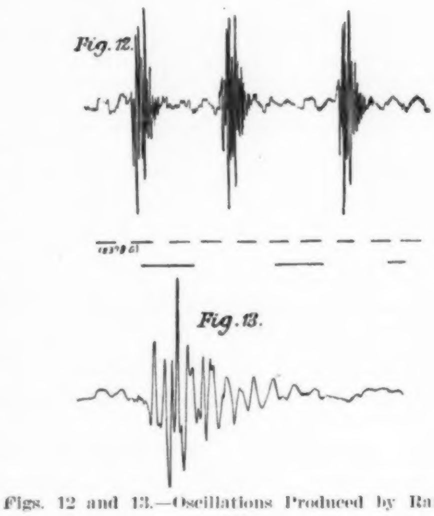
We pass to the registering devices, which are illustrated in Figs. 1 and 7, the two diagrams being sections at right angles to one another; records are produced in kinematograph fashion. The film is unwound from the roll T_1, passes over roll T_2, on which it is struck by the light ray (Fig. 7) and wound on roll T_3. The light ray from the lamp L_1 has been reflected up the bellows by the mirror M (Fig. 1) and has passed through a cylindrical lens before reaching T_2. T_3 is turned by a clock-work, and the feed can be varied within 0.5 millimeter and 100 millimeters per second, by means of gearing and vanes (see Fig. 1); thus, even very rapid oscillations can well be recorded. As the film speed will not be quite uniform, time-marks are made on each diagram with the aid of the lamp L_2 (Fig. 1) and the fixed mirror M_2; the circuit of this lamp comprises a chronometer and a second-interrupter. The other mirrors of Fig. 7, M_1 and M_3, and the screens of red glass and of ground glass are added in order to allow the observer to watch the light spot while it is being photographed. Part of the ray is reflected by the cylindrical lens in front of T_2, and sent to mirror M_2 and to the screen of red glass which the observer watches. While ordinary photographing goes on, the plane mirror M_1 will be hanging down as indicated in Fig. 7, in which position it closes the camera box; when a kinematograph record is not desired, M_1 is turned through 45 degrees, and the light spot will then appear on the ground glass screen. The whole recording box can be shifted on the platform of its tripod in a plane at right angles to the plane of the pendulum oscillation; by adjusting the screw S_1 (Fig. 2) an adjustment in this plane itself is obtained. The arrangement hence offers the advantages of a cross-slide fixture.

The box is not affected by the oscillations of the instrument; the bellows do not transmit any concussions, the tripods stand on rubber plates, and the casing of the seismometer does not touch the mechanism. The instrument has been designed to be readily portable; it fits into two small portmanteaus; for transport by rail each of the two parts should be packed into a special box, which is provided with cushions. The instrument is easily mounted; Dr. Mintrop wants, on an average, 13 minutes to be ready for observations.

The second instrument, the universal pendulum of Dr. Mintrop, consists, as we stated already, of two horizontal pendulums and one vertical pendulum. The plan (Fig. 8) shows that the two horizontal pendulums



Figs. 10 and 11.—Tremors Produced by Fall of a Four ton Weight at 125 Meters and 510 Meters, Respectively.



Figs. 12 and 13.—Oscillations Produced by Ramming Piles.

Fig. 14.—Oscillations Produced by a Bursting Projectile.

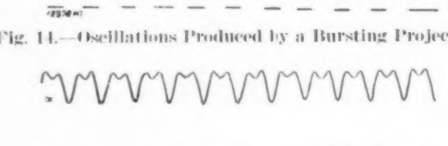


Fig. 15.—Oscillations from Gas Engine Running Steady.

are combined with one another at right angles, and that the vertical pendulum is mounted between them, on the same base and framing. The vertical pendulum (Fig. 9) is suspended from the standard U which holds the spiral spring V; the spring V is, through the adjustable screws W, connected with the strong lever X in such a manner that the point of application of the spring can be varied with the object of varying the sensitiveness of the instrument. The heavy mass is again a lead cylinder, of 1.5 kilogrammes weight, resting in the one arm of X, of which it forms part. The one end of X is further supported by the crossed flat springs F_5 which act as a pivot; at the other end of X is a flat spring support P_3, of the same kind as in the horizontal pendulum, and the crossed springs F_6 transfer the movement of X over to the lever N_1 and to the mirror; the registration is also obtained in the same way as previously described. The oil-damper is, in this case, placed immediately below the heavy lead cylinder. Dr. Mintrop intends to substitute electromagnetic damping for the oil-damping.

With the aid of these instruments and of the others

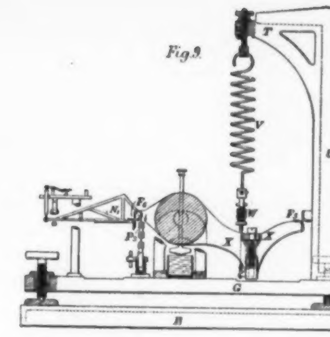


Fig. 9.—The Vertical Pendulum.

previously mentioned, the movements of the ground are continuously being observed at Bochum. Some of the curves which we reproduce were obtained by Dr. Mintrop at Göttingen, where Prof. Wiechert has his geophysical observatory on the Hainberg, a hill situated within a mile or two of the town. Seismographs are never at rest, of course. Even in the quiet country there is distinct evidence of a "local unrest;" in industrial towns the constant disturbances produce close (very short period) oscillations of not inconsiderable amplitude. In several of the special experiments, a ball of steel, 4 tons in weight, presented by Messrs. Krupp, was dropped through a height of fourteen meters (46 feet) on the firm limestone soil. Observations were taken at different distances. The curve shown in Fig. 10 was obtained 125 millimeters from the spot, with a magnification of 5,500; the curve (Fig. 11) 510 millimeters from the spot, with a magnification of 50,000. The dashes at the bottom of the curves are second marks, one second corresponding to the space from the beginning (or end) of one dash to the beginning (or end) of the next dash. At the first-mentioned distance of 125 millimeters the periods of the preliminary tremor and of the principal waves were 0.02 and 0.08 second, and the maximum amplitudes 730 and 3,600 $\mu\mu$(millionths of a millimeter). At a distance of 2,500 millimeters the preliminary tremors and the principal wave could no longer be distinguished in the curves; the actual amplitude there amounted only to 1/500,000 millimeters and 1/200,000 millimeters.

Figs. 12 and 13 show the oscillations produced in the sandy soil of the Emscher Valley during ramming operations by a tup of 4 tons weight falling on piles through a height of 0.9 meter (about 3 feet). The two diagrams show the oscillations in two planes at right angles to one another, obtained at a distance of 38.5 meters from the spot, with a magnification of 1,780.

The curve of Fig. 14 was obtained when a projectile burst on the ground about 1,500 meters (1 mile) from the instrument; the magnification was 5,000, the feed 9 millimeters per second. The curve has some of the characteristics of a seismogram from the far distance, thousands of miles from the observatory the preliminary tremor and the principal waves are quite distinct. Blasting operations gave similar, but, as a rule, less characteristic curves, because the disturbances are not so strong in ordinary practice.

Some interesting observations were also made at Göttingen on the oscillations caused by the working of the four-cycle 400 horse-power gas-engine of the Municipal Electricity Works; during the experiments the other engines were stopped. This engine was normally run at 145 revolutions per minute, and at 400 meters from it the curve (Fig. 16) (a part of the diagram only is reproduced) was obtained. The feed was 3.2 millimeters per second, and the magnification 5,500.

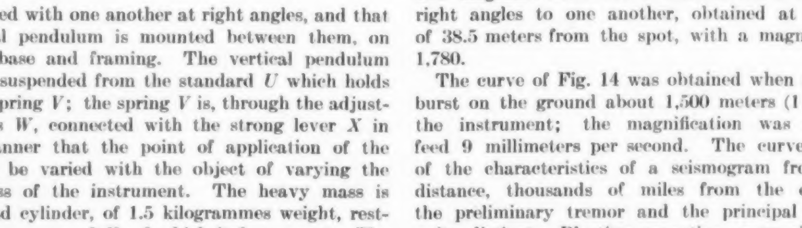


Fig. 16.—Oscillations on Starting Up Gas Engine.

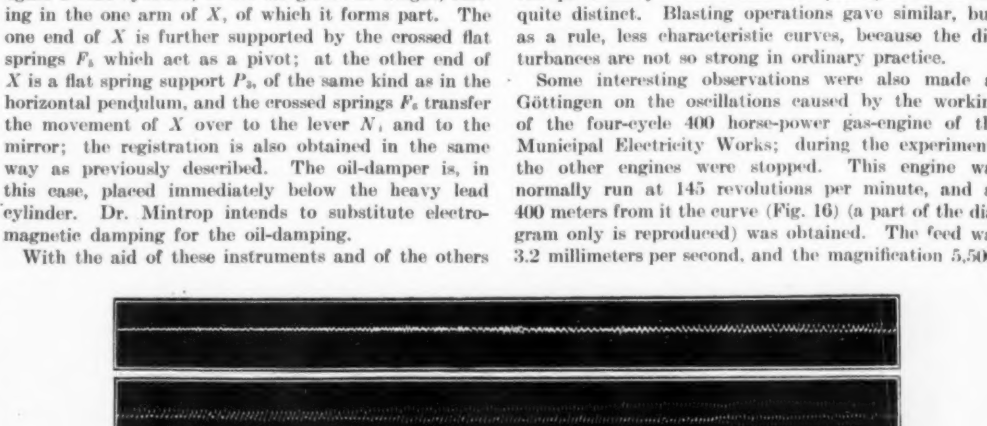


Fig. 17.—Oscillations Produced by Passing Goods-train.

The diagram, as reproduced, begins 20 seconds after starting the engine. The starting, it will be seen, hardly had any immediate effects upon the instrument at that distance of 400 meters. The oscillations in the first part of the diagram merely reflect the "local unrest." When the speed of the engine had come up to about 70 revolutions per minute, the periodicity of the engine became apparent; after about a minute the amplitude of the oscillations began to increase noticeably, while the period diminished. The maximum oscillations in the last part of the curve show a tendency to racing just before the load was put on. Afterward the load on the motor made little difference in the curve; it showed chiefly in so far as it affected the period. At steady running the curve (Fig. 15) was secured. In this curve, for which a magnification of 11,300 was used, two superposed periods can easily be distinguished, and Dr. Mintrop's calculations demonstrated that the forces coming in question during the working of the engine should cause a fundamental vibration and a secondary vibration of double frequency, while the higher components could be neglected.

In the two curves illustrated the plane of the pendulum oscillations coincided with the vertical plane through the engine and the spot of observation. Other curves were obtained in other planes, and the harmonic analysis of these curves yielded the following results as to the maximum amplitude of the fundamental oscillation I, and of the secondary oscillation II. The amplitudes are expressed in $\mu\mu$ (millionths of a millimeter). The first column indicates the angle between the pendulum plane and the vertical plane, reckoned clockwise.

Angle.	Maximum Amplitude in $\mu\mu$.	
	I.	II.
Deg.		
0	304	228
45	438	288
90	655	198
135	545	139

Similar observations were made at twelve spots in different directions and at different distances from the gas-engine. At 4 kilometers distance the maximum amplitude had diminished to 25 $\mu\mu$, and the secondary oscillation was no longer traceable. This decrease followed a regular law. Some curves were spoiled by a rush of cattle at the railway station. In the administration building of the electricity works, which a strong wall connects with the engine house, the observations tabulated in the next column were made; the second column of the table indicates the height in meters of the spot on which the instrument was placed above normal datum:—

	Height.	Amplitude in $\mu\mu$.	
	m.	I.	II.
Concrete floor, basement..	−0.3	3050	2120
Ground floor, boards......	+1.8	1950	2520
First floor, stone..........	+5.6	3850	5130
Second floor, stone........	+9.7	4070	7800

The oscillations produced by a Nurnberg gas engine of 1,200 horse-power, running at 107 revolutions, were much more pronounced at 210 meters from the engine house on the ground than they were at 100 meters distance underground, in a mine at a depth of 400 meters.

Fig. 17 finally illustrates curves recorded by the universal pendulum. A goods train was passing 50 meters from the instrument; the magnification for the two horizontal components was 500, for the vertical component 600.

We should add that the instruments were supplied by Messrs. Spindler and Hoyer, of Göttingen, or made at Bochum under Dr. Mintrop's supervision. The spiral springs and all the flat springs are of steel.

Electrophysical Explanation of Gravitation*

An Analysis of the Cause of Gravitation and Comparison with the Gravitational Constant on the Basis of Corpuscular Rotation

By Albert C. Crehore, Ph.D.

A simple explanation of the force of gravitation follows as a direct consequence of the hypothesis of corpuscles revolving within the atoms at high speeds approximating the velocity of light. To understand this let us consider the fundamental solution of the problem of the moving charged sphere.

Take the case of a single corpuscle moving in any curve with velocity q. In the solution for this case it has been shown that the electrostatic field surrounding the sphere, which is uniformly distributed in every direction while the corpuscle is at rest or moving with velocities slow compared to that of light, becomes polarized, so to speak, as the velocity increases toward that of light. The poles are the two points on a diameter of the sphere, the one being on the side toward which the sphere is moving and the other on the side from which it is moving. The circle half way from pole to pole may be called the equator. The effect of the motion is to crowd the radial tubes of electrostatic force away from each pole and concentrate them nearer to the equatorial plane. The concentration is symmetrical with respect to the equator, that is, they are crowded away from the rear pole toward the equatorial plane as much as they are from the forward pole. Simultaneously with the crowding of the tubes of electric force a magnetic field is generated, which becomes stronger as the velocity increases. The lines of magnetic force are circles in planes perpendicular to the direction of motion of the sphere, having their centers on the path of the center of the sphere. These circular tubes of magnetic induction are crowded together most at the equatorial plane where the force is greatest, and as the velocity of the corpuscle increases they become more and more crowded, forming a plane sheet in this equatorial plane, and leave all other regions both behind and in front of the equator. At the velocity of light all of the electric and magnetic force is concentrated in this plane equatorial sheet.

The velocity of the corpuscles is supposed to approach to within an exceedingly small difference less than the velocity of light, the difference being represented by numbers of the order of 10^{-60} centimeters per second. In these circumstances it is proper to consider that the magnetic field accompanying all corpuscles moving with such velocities is confined within narrow limits to the equatorial plane, the field strength both in front of and behind the plane being zero, and that in the plane very intense.

CIRCULAR ORBITS.

In the atoms the orbits of the corpuscles are circular paths, having the center of the sphere as their common center. The magnetic field of a corpuscle under these conditions is confined to a plane containing the center of the corpuscle and the center of the sphere, the plane of the field being perpendicular to the orbit. Fig. 1 represents this condition, the plane of the paper being the plane of the orbit; the corpuscle at A moves in the circle with O as center, which is also the center of the sphere. The line $QA'OAB'$ represents the intersection of the plane of the magnetic field due to the moving corpuscle A with the plane of the orbit, the plane of the field being perpendicular to the paper. As the corpuscle revolves in its orbits this magnetic plane accompanies it, revolving about the axis of the orbit perpendicular to the paper at O.

* Adapted from *The Electrical World*. The paper here presented forms an excerpt from a larger work in course of preparation.

EFFECT OF CORPUSCLE ON AN EXTERNAL ATOM.

There is no limit to the distance to which the magnetic sheet due to the motion of the corpuscle in question extends, the equatorial plane OB extending on every side indefinitely far as it revolves. Let sphere at B represent

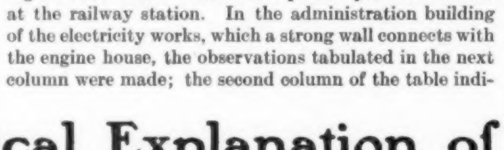


Fig. 1—Magnetic Field of the Corpuscle.

another atom, a sphere of positive electricity containing a ring of corpuscles. As the magnetic plane OB due to the corpuscle A, in describing its revolution at a uniform rate, strikes the sphere of positive electricity B, this sphere experiences a momentary force of attraction toward the corpuscle at A. This force lasts for a brief time only, while the plane of the magnetic field OB is moving across the sphere B, that is, while it describes the angle α, the apparent diameter of B as seen from O.

The reason that there is an attraction on the sphere B during this brief time is because the magnetic field of force, having a direction perpendicular to the plane of the paper at the position of sphere B, is moving at high velocity in the plane of the paper in a direction perpendicular to the magnetic plane AB. This moving magnetic field produces, as is well known, an emf at right angles to each of the former directions, that is, an emf within B in a direction toward the center O in the plane of the paper.

There is reason to believe that the magnetic planes do not have a similar effect upon the negative corpuscles within the sphere of positive electrification, because they are in rapid motion accompanied by magnetic sheets, as pointed out later, and the effect on the corpuscles is taken as zero.

When the corpuscle arrives at A', the point diametrically opposite in its orbit, the plane of its magnetic field again sweeps across the atom B, after A has made one-half a revolution. In this manner the force upon the atom B due to the corpuscle A is not a continuous force, but is a rapid succession of pulses, one every half revolution of the moving corpuscle A.

If there were two or more corpuscles in the ring of the atom, each would have an equal effect upon the sphere at B, but the forces would not be simultaneous. They would, however, be additive or cumulative, and the total force would be proportional to the number of corpuscles in the atom. In like manner the force on B depends upon the number of units of positive electricity in the atom B, and as this is the same on the average as the charges on the corpuscles within it we see that the law of force of attraction depends upon the product of their number of corpuscles, that is, upon the product of their masses.

DIFFERENTIAL EFFECT.

In the simplified explanation just given, attention was not directed to the fact that when the corpuscle is on the farther side of the orbit at A' the transit of the magnetic plane across the atom B developes an emf at B in the opposite direction to that which is developed when the corpuscle is at A, the nearer point in the orbit. That is to say, the impulse which the atom B receives when the corpuscle is at A' is a repulsion away from O, and when it is at A the force is an attraction toward O, for the direction of the transit of the magnetic plane across the atom B is the same during each transit, the rotation being, say, clockwise; but the magnetic field itself is reversed, being in a downward direction perpendicular to the paper in one case and in an upward direction in the other. The two impulses which succeed each other every half revolution are, therefore, first an attraction when the corpuscle is at A and a repulsion when it is at A'; but the attraction is always the greater of the two forces because the corpuscle at A is always nerarer to the atom B by the diameter of the orbit of A, and consequently the magnetic force is slightly greater during the passage at A than at A'. The duration of the time of transit is exactly the same in each case, since the plane revolves around the axis O.

This differential effect accounts for the fact that the force of gravity is so infinitesimally small. It has been recognized for a long time that gravity must be some effect of the second order of magnitude smaller than corpuscular forces, and the above explanation of gravity accounts for this fact satisfactorily.

All revolving corpuscles cause a resultant attraction.

It might be supposed without further consideration that another atom near that at O, in which the rotation of the corpuscles in their orbit is in the opposite direction, say counter-clockwise instead of clockwise, might entirely neutralize the force due to the atom O. That this is not true is easily explained, for if the corpuscle revolves in the opposite direction both the direction of the magnetic field at B and the direction of transit of the field across the sphere are reversed together, the result being that the force is still an attraction when the corpuscle is at the nearer point corresponding to A, and a smaller repulsion when at the farther point corresponding to A'. The effect of the motion of each corpuscle in its orbit is therefore an attraction upon B, no matter in which sense rotation takes place.

Force of gravitational attraction inversely proportional to the square of the distance and directly proportional to the square of the velocity of the corpuscle; that is, to the total kinetic energy of all the corpuscles in a body.

The value of the force of gravitational attraction will now be calculated upon the hypothesis that it is due to the revolving magnetic sheets. The value of the magnetic force at any point near a moving electrical charge is given by the expression

$$H = \frac{\mu eq(1-\beta^2)}{r^2(1-\beta^2 \sin^2 \theta)^{\frac{3}{2}}} \sin \theta, \qquad (1)$$

where μ is the permeability, q the velocity, $\beta = \frac{q}{v}$, v the velocity of light, r the radius vector joining the center of the charged sphere with the point, and θ the angle between the direction of motion and the radius vector, r.

For moderate velocities β is small compared to unity, and the value of H becomes

$$H = \frac{\mu eq}{r^2} \sin \theta, \qquad (2)$$

To find the total induction cut by the atom B, calculate the integral of HdA (Fig. 2) from $\theta = 0$ to $\theta = \pi$, in a ring of radius r with width $2b$. The elementary area $dA = 2brd\theta$. Using formula (2), we have

$$N = \int HdA = \frac{2\mu eqb}{r} \int \sin \theta d\theta = -\frac{2\mu eqb}{r} \cos \theta.$$

Between the limits 0 and π, $\int_0^\pi \cos\theta = -2.$ (3)

Hence, $N = \frac{4\mu eqb}{r}$, for one-half a revolution. (4)

If we use the value of H in equation (1) for any velocity, instead of that in (2) for slow velocities of the corpuscle, we find

$$N = \int H dA = \frac{2\mu eqb}{r}(1-\beta^2)\int \frac{\sin\theta d\theta}{(1-\beta^2\sin^2\theta)^{\frac{3}{2}}}. \quad (5)$$

This integral equals

$$X = -\frac{1}{(1-\beta^2)}\,\frac{\cos\theta}{(1-\beta^2\sin^2\theta)^{\frac{1}{2}}}, \quad (6)$$

and
$$N = -\frac{2\mu eqb}{r}\,\frac{\cos\theta}{(1-\beta^2\sin^2\theta)^{\frac{1}{2}}}. \quad (7)$$

Between the limits of 0 and π, $-\frac{\cos\theta}{(1-\beta^2\sin^2\theta)^{\frac{1}{2}}} = 2$, (8)

and
$$N = \frac{4\mu eqb}{r}, \quad (9)$$

which is the same as the result obtained in (4) by means of the simplified formula (2) for slow velocities. The general formula (7), however, is good for all values of the

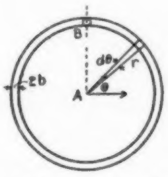


Fig. 2.—Diagram Showing Meaning of Symbols.

angle θ, and by this the effective width of the magnetic sheet when the corpuscle has a velocity approaching that of light may be determined. They are exceedingly thin sheets.

To find the electric force acting upon the sphere of positive electricity B, we may calculate the emf due to the rate of cutting of the magnetic field. If t is the time required by the magnetic plane of the corpuscle A to make the transit of the atom B, the rate of cutting the induction is $\frac{N}{t} = E$, the emf. Since the force lasts for a brief time only, during the transit of the plane, and is thus of a pulsating nature, the effective emf is equal to the actual emf multiplied by the portion of a second during which it acts. If the magnetic plane makes n transits per second when the corpuscle is at A, the total time that the emf lasts is nt. Hence,

$$E = \frac{N}{t}nt = Nn = \frac{N}{T},$$

where T is the period of the corpuscle. Since $\frac{1}{T} = \frac{q}{2\pi a}$, where a is the radius of the ring of corpuscles of which A is one, we have

$$E = \frac{2\mu eq^2b}{\pi ar} \quad (10)$$

To simplify the calculation, the positive sphere B is considered as a cube with sides equal to $2b$. Its charge is e', and volume $8b^3$. Hence the density $\rho = \frac{e'}{8b^3}$. As the magnetic sheet due to A sweeps across this volume its width, w, is exceedingly small compared to the diameter of the atom. The width of this thin sheet, w, may be defined by stating that all but a very small percentage of the total induction is contained between its two bounding surfaces. When the magnetic plane cuts the atom it acts only upon an elementary volume equal to $4b^2w$, and the charge within this volume is $4b^2w\rho = \frac{we'}{2b}$.

Since (10) expresses the average emf—that is, the force upon a unit charge—the force upon the charge acted upon can be determined by multiplying (10) by $\frac{we'}{2b}$. If use is made of electrostatic units it should be remembered that $\mu = \frac{1}{Kv^2}$, where K is the specific inductive capacity and v the velocity of light. Hence

$F = \frac{q^2wee'}{K\pi arv^2}$ = force upon atom B for one-half revolution of A. (11)

Applying this result to the case of the corpuscle revolving in a circular orbit of radius a, whose center is at a distance R from the center of the attracted atom B, we have, for the half revolution nearer to B, $r = R-a$, and, during the half farther from B, $r = R+a$, and, therefore, the average attraction during the whole revolution of the corpuscle is

$$F = \frac{q^2wee'}{K\pi av^2}\left(\frac{1}{R-a} - \frac{1}{R+a}\right)$$

This reduces to

$$F = \frac{2q^2w}{K\pi v^2}\cdot\frac{ee'}{(R^2-a^2)} \quad (12)$$

Law of force directly proportional to the product of the masses and inversely to the square of the distance.

The complete expression for the force of gravitation in equation (12) shows that the attraction varies directly as the product of the masses and inversely as the square of the distance, other things being constant, when R is large compared to a, the radius of the ring of revolving corpuscles within the atom. This is the ordinary gravitational law. But we see that when the distance R is small, approaching molecular distances, the expression indicates an increase of the gravitational force. The increase in the rate of change of the force within molecular range is well known. The expression (12), therefore, includes both great and small distances. However, it must be remembered that in deriving this formula the magnetic induction in the sheet accompanying the revolving corpuscle was considered to be uniform throughout the volume of the positive sphere B of the attracted atom. When the distance is very small the induction should be integrated throughout the volume, and the expression must not be used in case R is nearly equal to a.

THE GRAVITATIONAL CONSTANT.

To make any comparison between the constant in equation (12) calculated from this theory of gravitation and the well known astronomical gravitational constant it is first necessary to find some relation between the units employed. In the one case the unit is the gramme and in the other the corpuscle or electron. To make the comparison we must know approximately the number of corpuscles in a gramme. Fortunately we can find this number with a fair degree of accuracy. For example, in the case of any gas at 0 deg. Cent. and 760 millimeters pressure, there are approximately 2.7×10^{19} molecules per cubic centimeter. In oxygen there are two atoms per molecule, and 700 cubic centimeters of gas weigh one gramme. There are, therefore, 3780×10^{19} atoms per gramme.

The exact number of corpuscles in an atom of any gas is determined for each element by a special method developed by the author. In the case of oxygen there are fourteen corpuscles per atom, and hence there are for oxygen 5.29×10^{23} corpuscles per gramme.

In a similar manner this number has been determined for many elementary and compound gases for which the data are known, as follows:

Substance	Corpuscles per Gramme.
Hydrogen	16.2×10^{23}
Helium	6.05×10^{23}
Nitrogen	5.17×10^{23}
Oxygen	5.29×10^{23}
Fluorine	5.10×10^{23}
Neon	5.14×10^{23}
Chlorine	5.29×10^{23}
Argon	5.00×10^{23}
Bromine	5.21×10^{23}
Krypton	7.26×10^{23}
Xenon	5.66×10^{23}
CO_2	5.35×10^{23}
CO	5.60×10^{23}
H_2S	5.32×10^{23}
H_2O	5.44×10^{23}
NO	5.24×10^{23}
NO_2	5.48×10^{23}
NH_4	5.67×10^{23}
SO_2	5.28×10^{23}

The well-known astronomical gravitational constant obtained from observations of the earth's attraction upon bodies is 666×10^{-10}. This is the force in dynes between 2 grammes 1 centimeter apart. To find the gravitational force between two atoms containing one corpuscle each, together with its equivalent sphere of positive electrification, divide the gravitational constant by the square of the number of corpuscles per gramme, and find

$$A = \frac{666\times10^{-10}}{5.2^2\times10^{46}} = 24.6\times10^{-56}\text{ dynes.} \quad (13)$$

This is, of course, a hypothetical atom, since more than one corpuscle is required in a ring in any atom, but for purposes of calculation the result is the same as if we assume a certain kind of atom.

By the calculated formula (12) we find upon substituting $e = e' = 4.9\times10^{-10}$ electrostatic units, $q = v = 3\times10^{10}$, K and R equal to unity, and a small compared with unity, that

$$F = \frac{2\times4.9^2\times10^{-20}}{\pi}w = 15.3\times10^{-20}\,w\text{ dynes.} \quad (14)$$

Upon equating (13) and (14) and solving for w, the thickness of the magnetic plane of one corpuscle, we obtain

$$w = \frac{24.6\times10^{-56}}{15.3\times10^{-20}} = 1.6\times10^{-36}\text{ centimeters.} \quad (15)$$

The value of the thickness of the magnetic sheet thus obtained from a comparison with the gravitational constant is in agreement with the value we are led to expect from an examination of equation (7) by which the width of the plane may be calculated in terms of the velocity of the corpuscle. If we take the definite integral in (7) between the limits o and θ instead of between o and π to find the distribution of the induction, and if X denotes the variable factor

$$X = \int_0^\theta \frac{-\cos\theta}{(1-\beta^2\sin^2\theta)^{\frac{1}{2}}} = 1 - \frac{\cos\theta}{(1-\beta^2\sin^2\theta)^{\frac{1}{2}}} \quad (16)$$

Writing $w = \cos\theta$ we have

$$X = 1 - \frac{w}{(1-\beta^2+\beta^2w^2)^{\frac{1}{2}}} \quad (17)$$

The value of X becomes unity when we take the total induction from o to $\frac{\pi}{2}$. If we desire to find the velocity q which will give such a value of w that 99 per cent of the total induction is included between the two surfaces, we have

$$\frac{w}{(1-\beta^2+\beta^2w^2)^{\frac{1}{2}}} = 10^{-2}.$$

Solving for w, we find

$$w^2 = \frac{1-\beta^2}{1-\beta^2 10^{-4}}10^{-4}.$$

Since β is approximately unity we may neglect $\beta^2\times10^{-4}$ when substracted from unity and, substituting $\beta = \frac{q}{v}$, write

$$w^2 = \frac{v^2-q^2}{v^2}10^{-4} = \frac{(v+q)\ (v-q)}{v^2}10^{-4}$$

Putting $v+q = 2v$, and solving for $v-q$, we have

$$v-q = \frac{w^2v}{2}10^4 \quad (18)$$

Substituting the value of w obtained in (15) from the gravitational constant, and $v = 3\times10^{10}$, we find

$$v-q = \frac{1.61^2\times3}{2}10^{-58} = 3.9\times10^{-58}$$

It is seen by this calculation that if the velocity q of the corpuscle is 3.9×10^{-58} centimeters per second less than the velocity of light the astronomical gravitational constant may be directly calculated on this theory of gravitational attraction.

The important considerations here shown are that in the one case the well-known phenomena of gravitation are completely accounted for, and in the other the values of atomic weights are explained by assuming that corpuscles are revolving within the atoms in rings with velocities exceedingly near to the velocity of light, so that almost all of the magnetic induction lies between two surfaces not more than 1.61×10^{-36} centimeters apart. The corpuscle itself is supposed to have a diameter about 10^{-13} centimeters.

ACTION OF MAGNETIC SHEETS UPON NEGATIVE CORPUSCLES.

It is realized that the explanation of the force of gravitation here given entirely neglects the possible action of the magnetic sheets upon the negative corpuscles as being small in comparison with the action upon the positive sphere. If the negative corpuscles were at rest in the sense that the positive sphere is, then it is true that there would be an equal and opposite force upon the corpuscle neutralizing the effect upon the whole atom. The corpuscle cannot be regarded as a stationary charge, however, but as one moving so rapidly that its electric field is all concentrated in the equatorial plane and accompanied by a magnetic field in that plane which eclipses in effect the electric field. It is better to regard corpuscles as peculiar magnets which have a distinct polarity. While I have not been able to give a mathematical proof of this point, yet it seems clear that, as the magnetic planes of the rings of corpuscles within an atom are acted upon by the transit of the plane of an outside corpuscle, the resultant effect upon all the negative corpuscles for the whole atom must be small because the planes are turned at all possible angles, some corpuscles exactly neutralizing others.

POSITION OF THE ATOM B WITH RESPECT TO THE PLANE OF THE ORBIT OF A.

In the example represented in Fig. 1 the atom B is supposed to be located in the plane of the ring of corpuscles within the atom A; that is, in the plane of the paper. If B is not in this plane, but either above it or below it, the attraction of A for B diminishes as the angle increases for a given fixed distance between the atoms, and the attraction reduces to zero at the poles when B is upon the axis of the ring of corpuscles above the point O. This means that the force of gravity *for a single atom* is not uniform in all directions, but exhibits a polarization. It would be interesting if it were possible to test this by some form of experiment.

The effects of gravitation that we are accustomed to measure are due to multitudes of atoms and molecules. In such collections the planes of the rings of rotating corpuscles are turned at all possible angles, and the effect in this case is the same as if the atom B were always placed at some fixed angle with the plane of the orbit, the angle representing the mean of all possible positions. A constant factor is thus introduced modifying the actual value of the attraction, but the law of variation directly with the product of the masses and inversely as the square of the distance is not thereby affected.

GENERAL CONSIDERATIONS.

The speed with which gravitation travels has often been a subject of inquiry. This theory explains the mat-

ter. These magnetic planes of revolving corpuscles have been in existence since the atoms were formed, sweeping all space so that it is impossible for any object anywhere to escape being traversed by them in their universal reach. We can see that the rate of propagation of the magnetic force has nothing to do with the amount of attraction of gravitation. This depends upon the rate at which these planes cut, the body being attracted and upon the actual strength of the field. Nothing can change either of these effects unless the rate of revolution of the ring of corpuscles within the atoms be altered.

The formula (2), which gives the value of the magnetic force at any point in the medium surrounding a slowly moving corpuscle, was given by Sir J. J. Thomson in the *Philosophical Magazine* of 1881, and is based upon the electromagnetic theory. This was amplified later by Oliver Heaviside, who gave the more general formula (1), which is true for great as well as slow velocities. These formulas apply to a charge moving in any curve. The angle θ is the angle between the direction of motion and the radius vector from the center of the charge to the point in question. When the motion is in a circle these equations show that H, the strength of the field, is a maximum at all times and places on the radius vector OA joining the centers of the orbit and the corpuscle.

To some this presents a difficulty because, even for slow velocities, if we go far enough away from the corpuscle we come to a point where the position of the maximum point of the field must be changing at a velocity in excess of the velocity of light. If the corpuscle itself has nearly the velocity of light this maximum position must have a velocity greater than that of light at all points outside of the orbit. If the energy of the field is changing with the velocity of light, it is possible that the position of the maximum strength of the field may travel much faster than light.

The final test of any gravitational theory is the velocity of transmission. It is known that if gravitational forces were transmitted with a speed no greater than that of light the positions of comets coming into our solar system would measurably deviate from the positions they are observed to occupy. Here is an experimental observation which demands a velocity of transmission greater than that of light, and astronomical distances are required to obtain information of this kind. This gravitational theory meets this demand. If two bodies are approaching each other with any velocity you please, the number of transits of the magnetic field per second remains the same, and the attraction obeys the inverse square law exactly. If they approach not directly but at an angle, the number of transits per second for a single attracting atom is altered; but every body is made up of multitudes of atoms, and the attracting planes are moving in all possible directions, so that the gain due to one is counterbalanced by the loss due to another, the average attraction being independent of the lateral motion.

To reject this theory merely because of the difficulty in admitting that the position of the maximum point of a magnetic field travels faster than light involves a rejection of equations (1) and (2), and with them the electromagnetic theory upon which they stand. In addition to this, any theory of electricity and magnetism which may be substituted for the theory upon which these formulas are based will have to encounter the same difficulty in explaining the apparently infinite velocity of transmission of gravitation.

The power of this theory of gravitation to explain phenomena will be found to be very great, and the foregoing description of the theory is given as preliminary in the hope that it may prove useful to others.

Meerschaum.—It seems that the origin of this word has not been definitely established. Some claim it to be a transmutation of the words *myrsen* or *myrschen*, as this mineral is named in Asia Minor, where it occurs in blocks from the size of a fist to the size of a man's head. This derivation is, however, doubtful; it is much more likely that the Italians, who in former days had been the commission agents for this disintegrated product of serpentines, first named it *schiuma del mare* (sea foam) on account of its lightness and appearance. From the Italian it was taken over into most of the modern languages. The property of meerschaum to turn a bright brown color on exposure to heat, after having previously been treated with melted wax is said to have been accidentally discovered by a cobbler of the name of Koneatch, who lived in Budapest (Hungary) in the middle of the seventeenth century, and who also was a skilled wood carver. While at work on a meerschaum tobacco pipe belonging to Count Andrassy, he dropped the bowl on a piece of wax, which he used for waxing this thread. Picking it up, he simply wiped off the wax adhering to the bowl; but later when the owner began smoking the pipe there appeared a beautiful dark brown spot on the bowl, where it had come in contact with the wax. The observant cobbler was not slow to take advantage of his discovery, and thus, it is said, arose the practice of waxing meerschaum pipes.—*Kölnische Zeitung.*

Science Notes

Herrings as Fertilizer in Japan.—In Japan about four million tons of herrings are caught every year. This enormous quantity is not by any means entirely used up for human consumption. In fact, about four-fifths of the entire quantity is used as organic fertilizer for the rice fields.

Ripening Cheese by Electricity.—One of the most recent applications of electricity which has come to our notice is that for ripening cheese. The use of electricity for maturing various articles of consumption, such as wines and alcoholic liquors, is not new, but Mr. Gokkes' method of applying an alternating current of 2 amperes and 10,000 volts for the purpose of ripening cheese appears to be so. The treatment, as described in *Cosmos*, is continued for 24 hours, and is said to effect in this short time a complete ripening of the cheese.

Peculiarities of the Calendar.—Some facts about our calendar, which are obvious enough, but which have probably escaped the attention of the majority of our readers, are well worth quoting from *Die Welt der Technik*. Thus, the month of January always begins the same day of the week as the month of October. The same is true with regard to April and July, September and December. Again, February, March and November also begin with the same day of the week. This, however, is true only in normal years of 365 days. A century can never begin on Wednesday, Friday or Saturday. Furthermore, the ordinary year ends on the same day of the week as it begins.

Platinum-osmium Instead of Platinum-iridium.—Since platinum is too soft for use for various practical purposes, it is customary to harden it by the use of iridium as an alloy. Experiments by W. C. Heraeus show that osmium is much superior for this purpose, first because only 2 per cent osmium takes the place of 5 per cent iridium. Secondly, the osmium alloy is much more elastic. Still larger percentages of osmium may be used and produce increased hardness, but when 20 per cent is reached the alloy is so brittle as to be useless for technical purposes. It is necessary that the osmium have a high degree of purity, as very minute quantities of iron or copper affect the hardening process unfavorably.

The Teeth of Prehistoric Man.—It has been observed for some time that the teeth of adult skeletons dating from the neolithic period show an abnormally high degree of wear as compared with modern teeth or those of the middle ages. Mr. Marcel Baudouin quoted in *Cosmos*, suggests that this excessive wear of the teeth is due to the fact that the neolithic men consumed a food largely contaminated with sand; this appears quite probable since they seem to have lived on roots and grain and similar materials crushed in very primitive mills, usually made of earthenware. Mr. Boudouin confirmed his supposition by the observation that among the earth-eating tribes of Siam a similar wear of the teeth is observed, even in greater degree than among the neolithic men. It does not seem likely, therefore, that the latter practiced geophagism, that is to say, eating earth. Probably the mere admixture of sand with food is sufficient to account for the observed condition of their teeth.

Printing a Positive from a Positive.—The need occasionally arises to prepare a positive copy from a positive transparency. Ordinarily the only means of effecting this is to first print a negative and then copy this a second time. The following method given by Lumière and Seyewitz is published in *La Nature* and should prove of interest: The plate is first exposed in the usual way and developed rather fully in any suitable developer, such as diamido-phenol, and is then washed for about a minute. It is next laid with its back against a piece of black paper, which is wetted so as to adhere to the glass. The developed plate is then exposed to the light and is immersed in the following solution: Water, 1,000 cubic centimeters; sulphuric acid, 10 cubic centimeters; potassium permanganate, 1 gramme. This dissolves off the silver image. The temperature of the bath should not exceed 20 deg. Cent. After the plate has become entirely transparent, which occurs in about two minutes, the plate is laid in a 2 per cent solution of sodium bisulphite in order to bleach it, and is then washed for one minute. The next step is to fix thoroughly in a 10 per cent solution of sodium bisulphate ("hypo"); finally, the image is developed in the following bath: (a) Water, 1,000 cubic centimeters; anhydrous sodium sulphite, 180 grammes; mercuric bromide, 9 grammes; (b) water, 1,000 cubic centimeters; anhydrous sodium sulphite, 20 grammes; metol, 20 grammes. For a plate measuring 13 × 18, take 150 cubic centimeters of *a* and 40 cubic centimeters of *b*. The image appears in about one minute, but works out rather slowly. After about an hour or an hour and a half the finest details are complete, and the results are as good as those obtained by the usual process. The bath remains clear in spite of the prolonged treatment.

Electrical Notes.

Wireless Telegraphy.—The development of wireless telegraphy during the past three years is remarkable. The *Berner Internationales Telegraphen Journal* gives the following figures: In January, 1909, there were 92 wireless land stations in action and 416 ships provided with wireless apparatus. On January, 1910, there were 136 land stations and 619 ships provided, and on January, 1911, there were 219 land stations and 988 ships fitted with wireless apparatus.

Emission of Electrons in Chemical Reactions.—Hitherto there have been essentially two experimental conditions known under which electrons are liberated from ordinary matter, namely, firstly, in the so-called radio-active changes, and, secondly, in the case of the the so-called photo-electric effect. This consists in the emission of electrons from certain substances when they are exposed to a beam of ultra-violet light. To these two cases must now be added a third, for it has been shown by Haber and Just that, under certain conditions, electrons are liberated in the course of chemical reactions. The particular reaction which these experimenters employed is that between alloys of sodium and potassium and certain strongly reactive gases, such as iodine vapor, phosgene, etc. When an electrometer is situated in the neighborhood of the reacting substances it accumulates a negative change, owing to the impact of electrons. As time goes on we are finding that electrons make their appearance at every turn in the investigation of physical science.

The Electron Theory of Catalysis.—Probably the most modern explanation suggested for that unsolved problem of the chemistry, catalysic action, comes to us from Mr. P. Achalme, whose work is noted in *Cosmos*. This writer suggests that molecules are formed from atoms linked together by negative electrons extruded from the atom. The action of the catalyses would then depend upon its capacity for furnishing electrons to or withdrawing electrons from the reacting system. As is well known, platinum, especially in the form of so-called sponge, is a very active catalyser in a number of reactions. Platinum is one of those substances that readily give up electrons. It thus requires a positive charge and attracts electrons around itself. If platinum sponge is introduced into a gas, the metal will tend to abstract from the gas molecules the electrons which bind their atoms together, and will thus form a transitory combination with the molecules of gas. If the electrons are thus retained by the metal, the gaseous molecule becomes disrupted. The atoms are thus set at liberty, but possessing a positive electric charge, which as a matter of fact has been actually observed. This theory seems to give an explanation of the catalytic reduction and oxidation in the presence of palladium, platinum, nickel, etc., which is so commonly observed.

The Earth's Population Classified According to Sex

Of recent years the custom of making systematic census of the population has become well established throughout all civilized countries, and it is now possible to gain a fairly accurate idea of conditions all the world over. Some of the figures cited in *Prometheus* in regard to this matter are interesting. The world's total population is estimated at 1,700 millions, out of which the proportion of the sexes is known for 1,038,000,000, the ratio being 1,000 males to 990 females.

The ratio varies very considerably in different places. In Europe there were, for every 1,000 men, 1,027 women; Africa, 1,045; America, 964; Asia, 961; Australia, 937. The maximum proportion of women is found in Uganda, 1,467; the minimum in the Alaska gold fields and the Malay States, with 391 and 380 respectively.

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